Techniques for farm-based assessment of sediment health associated with the commercial culture of Atlantic salmon (*Salmo salar* L.) in Tasmania.

By

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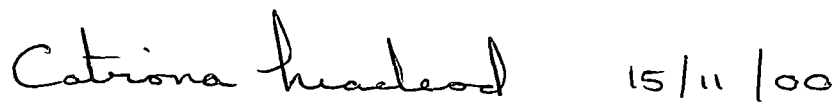
Statement

Except as stated herein this thesis contains no material which has been accepted for the award of any higher degree or diploma by the University of Tasmania or any other institution. To the best of my knowledge and belief this thesis contains no material previously published or written by another person except where due acknowledgement is made in the text.



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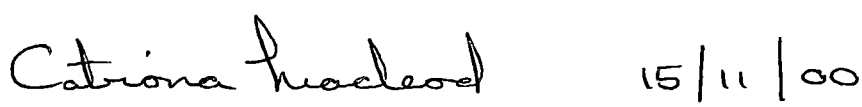

Catriona K.A. M. Macleod.

Abstract

Many studies have been carried out to evaluate the effects of organic enrichment on the marine environment, several of which specifically investigated the environmental impacts of cage fish farming. These studies have generally been conducted from a government or regulatory standpoint and to date, none have been undertaken from a farm-based perspective. Thus, there have been no studies aimed at improving the self-assessment capability of farms or developing farm management protocols to ensure environmental sustainability.

The current study was undertaken with both these objectives in mind. Initially, the project reviewed techniques routinely employed for monitoring of aquaculture operations as well as methods that have been used to evaluate other sources of organic enrichment in the marine environment. These techniques were then assessed according to three basic criteria; simplicity, reliability and robustness, to identify those that could be considered applicable for farm-based use. The methods thus selected included macrofaunal assessment, evaluation of sedimentation rates, determination of organic matter content, and measurement of sediment redox potential. These techniques were then evaluated at two fish farm leases to determine how they would respond to a) the spatial variability at each site, and b) the temporal effects of operational variability at the two sites over the production cycle. The performance of each technique was judged against species level evaluation of the macrofaunal community structure as an indicator of the sediment condition. The results suggested that both sedimentation rate and organic matter were unsuitable as farm-based measurements. Measurement of redox potential was found to be a simple and reliable indicator of sediment condition, accurately reflecting the benthic condition. However, the redox results should be interpreted with caution, particularly when taken in isolation. Time series redox measurement showing a clear pattern of effect is preferred. However, isolated redox measurements can be used when viewed in conjunction some other substantiating evidence.

Further examination of the macrofaunal results suggested that *Capitella capitata* complex abundance could also be a good indicator of sediment condition. However, once again, evaluation of the significance of this species complex is most useful

when the interpretation incorporates a time series of observations. The macrofaunal results also indicated that assessment of annelids to family level alone may be sufficient to determine site condition, an outcome that could markedly reduce the costs of benthic assessment to farmers. Finally, the results from other major faunal groups, showed some very interesting patterns which could prove useful in evaluating sediment condition. The abundance of echinoderms appeared to be directly related to environmental conditions; total absence indicating highly enriched conditions, dominance by *Echinocardium cordatum* suggesting moderately impacted conditions whilst a more diverse echinoderm fauna seemed to be indicative of unimpacted conditions. In addition, the molluscan community structure at each of the study sites exhibited a shift from bivalve to gastropod domination. This change was reflected at all sample stations and consequently suggests either that the reference locations for each of the sites were influenced by the farm or that the final gastropod species, an introduced species, may itself have induced the change.

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Chapter 1 – Introduction

1.1 Fin fish Culture in Tasmania

Worldwide the aquaculture industry is developing rapidly. Global per capita seafood consumption has been steadily rising since 1969, however landings from capture fisheries reached a plateau in 1989 and aquaculture has been bridging the gap since then (Chamberlain and Rosenthal, 1995). Most aquaculture facilities tend to be located in coastal areas and as these same areas also tend to be the locations for a variety of other industries and the focus of a number of recreational pursuits then it is not surprising that conflicts often occur.

There are several concerns which are commonly raised by both the public and government regarding aquaculture practices. One of the main concerns relates to the impacts of aquaculture operations on the marine environment and general water quality. Aquaculture, like any other industry or intensive livestock cultivation, will produce waste products which can directly affect the surrounding water body and seabed. Consequently, both public and regulatory concern is usually centred on the environmental sustainability of aquaculture operations. Sustainability, in this case, simply refers to management practices that will not ultimately degrade the environment (Chamberlain and Rosenthal, 1995). Farm managers are as enthusiastic as either government or the public to ensure the sustainability of their industry.

In Tasmania the primary fin-fish aquaculture species is the Atlantic salmon (*Salmo salar* L.). Although the practice of aquaculture has been around for approximately 4,000 years (Monahan, 1993), the farming of Atlantic salmon is a fairly recent practice, first undertaken in Norway in 1965 with fish raised in a closed off area of sea. The industry developed slowly in Europe in the 1960s and 1970s but with advances in technology proliferated in the 1980s (Monahan, 1993). In many cases in the northern hemisphere, initial site selection was poorly thought-out and often the greatest consideration was given to proximity to suitable land based infrastructure facilities with little or no thought given to environmental suitability. Consequently, over time many farm managers found that the conditions around their sites deteriorated and failed to continue to support good fish growth. Accumulation of

waste products (excess feed and faeces) beneath cages resulted in rapid deterioration of benthic conditions which in turn led to detrimental effects on fish health. In Tasmania, culture of salmonids began in 1964 with trials of rainbow trout, and this ultimately led to the development of the Tasmanian salmon industry. The industry was officially established in 1985 as a joint venture between a Norwegian company (NorAqua) and the State government. As salmonids are not native to the southern hemisphere the industry was started in 1984 using Canadian Atlantic salmon ova from a land-locked population at Gaden, NSW originally imported from Nova Scotia between 1963 and 1965 (Jungalwalla, 1991). To date the Tasmanian salmon industry has been extremely successful and has had no major problems; there are no significant diseases and the waters around Tasmania are amongst the cleanest in the world. However, it is recognised by both the State government and the industry members that it is very important that the development of this industry is conducted sustainably and that it avoids repeating the environmental mistakes that have been made elsewhere.

1.2 Environmental Effects of Fin fish Culture

The impacts of fish farm operations upon the environment are many and varied, and are influenced by a variety of different factors. Figure 1.1 shows a diagrammatic representation of some of the major environmental effects of fish farming. There have been many studies of the impacts of caged fish farming and a number of useful reviews have been published (Gowen and Bradbury, 1987; Rosenthal et al., 1988; Woodward, 1989; DePauw and Joyce; 1991; Iwama, 1991; Gowen and Rosenthal, 1993; Rosenthal, 1994; Wu, 1995). As indicated above, intensive culture of any animal produces waste products, and in the case of salmon culture these are primarily excess feed and faeces. The increase in sedimentary organic matter as a result of the deposition of these waste products causes changes in the benthic environment (Brown et al., 1987; Lumb, 1989; Weston, 1990; Kupka Hansen et al.; 1991; Ye et al., 1991; Holmer and Kristensen, 1992; Tsutsumi, 1995; Drake and Arios, 1997; Hargrave et al.). Fin-fish aquaculture is no different in the effects it produces to that from any other source of organic material (Brown et al, 1987; Weston, 1990; Holmer and Kristensen, 1992; Hargrave et al., 1997). Breakdown of this organic material requires oxygen; an excess of organic material may deplete the natural oxidising

capacity of the sediment and result in anoxic conditions. Sulphate reducing bacteria may then take over the degradation processes which, if conditions deteriorate still further, will subsequently be replaced by methanogenic microbes. However, it should be pointed out here that the production of methane from sediments only occurs under conditions of high organic enrichment (Raa and Liltved, 1991).

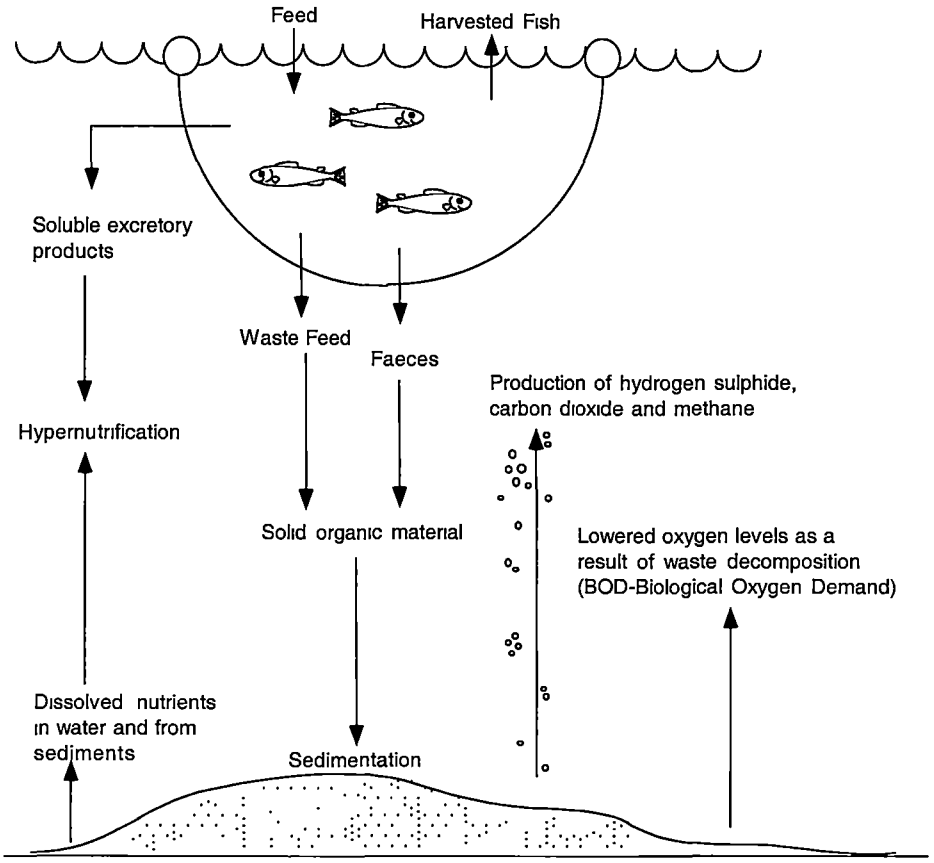


Figure 1.1 Some of the major environmental effects of cage aquaculture (adapted from Willoughby 1999)

Such changes in the sediment condition are clearly reflected both in the chemical and in the biological composition of the sediment (Brown et al., 1987; Weston, 1990; Hargrave et al., 1997; Karakassis et al., 1998). As the oxygen is depleted the oxic layer becomes shallower, and the macrofauna, which require oxygen to survive, are forced to inhabit a smaller area and are driven towards the surface. As the level of oxygen in the sediment further declines many species are eliminated altogether and some may be replaced by others more tolerant of a low oxygen environment.

Although the causes may remain unclear, there are several examples which indicate that ecological change associated with fish farming can result in deterioration in fish health as indicated by loss of appetite, irritated gills, decreased disease resistance and increased mortality (Braaten et al., 1983; Rosenthal and Rangeley, 1989). Black et al., (1996) provided evidence of gill damage in response to both chronic and acute exposure to hydrogen sulphide, the end product of sulphate reduction. It has also been suggested that oxygen depletion of the water surrounding cages may result in increased susceptibility to disease (Rosenthal et al., 1988). Consequently, farmers also need to know the condition of the sediment associated with their cage operations in order to ensure that they continue to provide their fish with the best opportunity for growth.

The impacts identified in figure 1.1 show that the water column is one of the main repositories for waste products. Early concerns were raised regarding the possibility of large scale eutrophication as a result of the increased dissolution of nutrients in the water column. These concerns have now largely been shown to be unfounded. Several studies have investigated water column nutrification and although there is some evidence of localised hypernutrification (Gowen and Ezzi, 1992) to date, this has only presented a problem in nutrient limited (particularly nitrogen limited) water bodies such as the Baltic (Persson, 1991) and in the Faroe Isles (Wildish et al., 1990). Eutrophication has generally been considered unlikely in non-nutrient limited, tidally energetic coastal waters (Gowen et al., 1990; Gowen and Ezzi, 1992). However, it should be noted that, very recently, debate has been re-ignited regarding whether hypernutrification associated with fin-fish farming can be associated with increased incidence of toxic algal blooms and the ensuing detrimental effects on shellfish production.

Impacts on the benthic environment are generally recognised to be those of most direct concern. Many other environmental factors can affect the degree to which the benthic environment is impacted: depth, current flow, flushing/ residence time for the estuary/water body, prevailing weather/ tidal conditions, stocking density, and feeding rates as well as the compounding effects of other inputs to the environment. Many studies have referred to the depth of the site as an important factor in determining the extent of environmental impact (Braaten et al., 1983; Rosenthal et

al., 1988; Beveridge, 1996). Deeper sites are generally considered more suitable for aquaculture operations as they allow more time for waste products to be dispersed in the water column (Braaten et al., 1983; Rosenthal et al., 1988; Beveridge, 1996). However, this does not mean that depth of water alone will mitigate the detrimental effects of organic enrichment from aquaculture. There are several examples from the fjordic Norwegian systems where deep water sites have become completely anoxic and no longer viable (Braaten et al., 1983; Persson, 1991; Gowen and Ezzi, 1992). It is the combination of many factors that provides the optimum conditions for successful aquaculture operations.

Current flow is another such factor and several authors have suggested that for successful marine aquaculture operations, the mean current flow should be in excess of $5cms^{-1}$ (Brown et al., 1987; Lumb, 1989). Other authors have suggested that flows less than this can be sustainable, but this is usually in conjunction with other factors such as tidal fluxes which provide re-suspension and removal of deposited matter (Gowen, 1991; Holmer, 1991; Edwards and Griffiths, 1996). The sediment particle size composition is generally a good indicator of the local water flow conditions. Rosenthal et al. (1988) separated all sediments into two basic categories related to sediment suspension characteristics and classified them as "depositional" or "erosional". Depositional sediments are dominated by fine sediments and represent areas of low water movement where detritus can accumulate whereas erosional sediments are coarser grained and indicate greater water flow and transport of fine particulate material. Even allowing for adequate depth and current flow in the area of the farm, if the flushing time for the water body does not allow sufficient removal of the particulate matter or results in re-deposition of the sediments upstream, then significant environmental impact can still occur (Gowen et al., 1983; Rosenthal et al., 1988; Frid and Mercer, 1989; Gowen and Rosenthal, 1993; Novotny and Pennel, 1996). Therefore simple measurements such as evaluation of sediment particle size can give farmers a good indication of site suitability.

When a suitable site has been selected, careful and responsible management of the aquaculture operation still plays an essential role in monitoring and mitigating any environmental impacts. The stocking density of the fish and level of feed input will have a direct bearing on the amount of organic material deposited on the seabed. In

the current aquaculture economy, profit margins are small and ensuring minimum wastage makes good economic as well as good environmental sense. Both farmers and environmental regulators accept that excessive enrichment of the sediments is undesirable, that this can be a contributing factor to reduced productivity at some sites and that severe degradation of the sediments is to be avoided. For sustainable farm production it is important that farmers monitor the sedimentary conditions within their leases. If the farmer can determine the extent of environmental degradation beneath his cages this will assist in deciding when to move cages. This information can in turn be integrated into the overall farm management plan for rotation of cages within the site and so allow optimal usage of the lease area. Monitoring the environmental impact status therefore makes good sense in the context of farm management. In order to make appropriate farm management decisions and ensure both sediment health and sustainable fish production are maintained it is necessary for farmers to be able to measure the appropriate environmental parameters. Consequently simple tools are required for the farmer to assess sediment health.

1.3 Techniques for Assessment of Environmental Impact

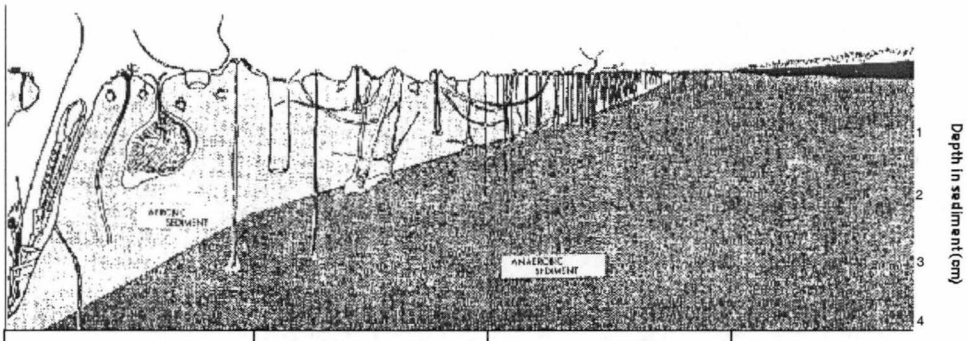
Although the literature pertaining to assessment of impacts is large the literature dealing with the techniques for monitoring the environmental impacts of aquaculture is much smaller. Those studies which have been undertaken have generally been in relation to monitoring requirements for governmental or legislative organisations (B.C. Ministry of Environment, 1988; Wildish et al., 1990; Chang and Thonney, 1992; Wildish et al., 1993; Hargrave et al., 1993; Black and Truscott, 1994; Ervik et al.,1994; SEPA, nd) or in order to distinguish particular levels of impact (Hensey in DePauw and Joyce, 1991; Johnsen et al., 1993; Hargrave et al., 1997). While many of the previously mentioned reviews (Gowen and Bradbury, 1987; Woodward, 1989; Iwama, 1991; DePauw and Joyce, 1991; Gowen, 1994) include descriptions of a variety of techniques for assessing the effects of organic enrichment, some of these techniques are too complex to be considered suitable for farm-based use. Nevertheless, many appear as though they may be useful and the results suggest that they could be applied on-farm with minimal modification.

Recent technological advances have made underwater video equipment less expensive and more widely available and consequently video survey has now been extensively applied in regulatory monitoring programmes eg. Scotland (SEPA, nd), Maine (Heinig, 1996), New Brunswick (Chang and Thonney, 1993) and British Columbia (British Columbia Environmental Assessment Office, 1998). In South Australia a recent investigation of the environmental effects of tuna farming (Cheshire et al., 1996), suggested that video surveys were useful for monitoring purposes, but also suggested that the technique required refinement. Most of the major developments in video assessment techniques have been reported too late for inclusion in the present study and when the study commenced, video technology was still too expensive to be practically included as a farm-based technique. Even with the most up-to-date information available (Crawford et al., in press), video assessment is at best only comparable with gross measurement of sediment chemistry and requires further validation before it can be considered as a sensitive and reliable farm-based assessment method.

A variety of differing measures of sediment chemistry have been adopted worldwide, however, measurement of both redox and organic carbon were amongst the most commonly applied techniques. In Scotland, Ireland, and in Washington state, USA redox and organic carbon are commonly measured (Codling et al., 1995). In New Brunswick, Canada, redox has been included as a standard measurement for some time but recently, sulphide measurements have also been recommended (Wildish et al., 1999).

Measurement of redox potential has been shown in many studies to be a useful indicator of organic enrichment (Pearson and Stanley, 1979; Brown et al., 1984; Weston, 1990; Hargrave et al., 1993; Karakassis et al., 1998). Measurement of redox quantifies the level of free OH^- ions in the sediment/ interstitial water and as such indirectly measures the level of oxygenation of the sediments. Redox measurement is one approach to measuring the degree of oxygen penetration in the sediments. In coastal sediments under natural sedimentation regimes oxygen will penetrate by diffusion only 2-5 mm into the sediment (Jorgensen and Revsbech, 1985) but in bioturbated sediment this oxidised zone is greatly extended. Pearson and Stanley (1979) showed that redox levels correspond well to the patterns of macrofaunal

community structure associated with the changing levels of organic enrichment as shown by Pearson and Rosenberg (1978) (figure 1.2). At redox levels less than –150 mV the fauna was found to be dominated by the opportunistic polychaete *Capitella capitata* complex (Pearson and Stanley, 1979), corresponding to the polluted stage (figure 1.2). The results for redox generally suggest that measurement is fairly simple and reliable and that the technique represents a robust means for assessing sediment condition. Consequently measurement of redox potential was included for evaluation in the current study.



ZONE	NORMAL	TRANSITORY	POLLUTED	GROSSLY POLLUTED
Typical Macrofauna Dominants	Nucula Amphiura Terebellides Rhodine Echinocardium Nephrops	Labidoplax Corbula Goniada Thyasira Pholoe Chaetozone Anaitides Pectinaria Myriochele Ophiodromus	Capitella Scoloplos	No MACROFAUNA Surface covered by bacterial fibre 'blanket'

Figure 1.2 Pattern of community structure change as a result of increasing organic matter loading (from Pearson and Rosenberg, 1978)

Measurement of organic carbon as an index of total organic content has also been included for assessment. This technique has been incorporated into many studies of the environmental impacts of fish farming with varying degrees of success. Studies by Hall et al., (1990) and Holmer, (1991) suggested that organic matter measurement was a reliable indicator of environmental impact but several other studies have yielded contradictory results (eg. Johannessen et al.,1994; Hargrave et al., 1997). As measurement of organic matter by loss on ignition (LOI) is a fairly simple technique it was decided to include organic matter measurement in the present study.

Measurement of the other major nutrient sources (eg. total nitrogen and phosphorus) or of other specific contaminants require complex analytical procedures as well as access to sophisticated laboratory facilities, which prohibit the adoption of such procedures for farm-based assessments. Other chemical techniques, included in

previous studies of mariculture impacts and which had been suggested to be good indicators of environmental impact, included measures of chemical oxygen demand (COD), biological oxygen demand (BOD) and respiration rates. All of these techniques require collection of a time series of data through either lab-based or *in situ* benthic chambers. The complexity of collecting and analysing these results suggested that these techniques would be inappropriate for farm-based applications.

One further technique that did, however, show potential for farm-based application was measurement of sedimentation rate. Results from several studies have indicated that the amount of organic material depositing under fish farms can be at least an order of magnitude greater than that at reference sites (Beveridge, 1996). There is evidence in the literature that the sedimentation rate is directly related to the level of organic enrichment and hence to the level of environmental impact (Gowen et al., 1988; Hall et al., 1990; Weston, 1990; Holmer, 1991; Ervik et al., 1994; Gilbert et al., 1997). Sedimentation rate is also fairly easy to measure by deployment of sediment traps, and is a technique which could be employed regardless of the depth of the site therefore does not encounter the sample collection problems which limit diver related techniques. Measurement of sedimentation rate was employed in British Columbia (British Columbia Environmental Assessment Office, 1998) and was determined to have potential as a farm-based monitoring technique.

Codling et al. (1995), in their summary of techniques used for environmental monitoring, determined that evaluation of benthic infauna was a direct and ecologically relevant measure of environmental impact. The response of the benthic community to organic enrichment is well documented. Pearson and Rosenberg (1978) identified four benthic community groups characteristic of varying levels of organic enrichment (Figure 1.2). The environmental effects of aquaculture have been shown to exhibit the same community responses (Brown et al., 1987; Weston, 1990; Hargrave et al., 1997; Karakassis et al., 1998). Evaluation of the benthic infauna has been shown in many studies to be the most sensitive indicator of environmental impact (Brown et al., 1987; O'Connor et al., 1989; Weston, 1990; Johannessen et al., 1994; Cheshire et al., 1996). Consequently macrofaunal community structure was chosen for evaluation in the present study and was selected as the primary means by which all other techniques were to be validated. However, the macrofauna was also

assessed with a view to identifying any indicator species or groups which in themselves may be useful for farm-based assessment.

Several species have been found to be indicative of areas of organic enrichment, most notably the opportunistic polychaete, *Capitella capitata* complex (Pearson and Rosenberg, 1978; Pearson and Stanley, 1979; Brown et al., 1987; Weston, 1990; Lim, 1991; Ye et al., 1991; Hargrave et al., 1993; Hargrave et al., 1997). This particular species complex has been identified globally in association with areas of organic enrichment (Pearson and Rosenberg, 1978) and has been shown in many studies of the effects of fish farms to be associated with areas of major impact (Pearson and Stanley, 1979; Brown et al., 1987; Weston, 1990; Lim, 1991; Ye et al., 1991; Hargrave et al., 1993; Henderson and Ross, 1995). Hargrave et al. (1993) actually encountered conditions which were sufficiently degraded as to inhibit *Capitella capitata* complex (the grossly polluted category in figure 1.2). Consequently, particular note was taken of *Capitella capitata* complex distribution in this study as a potential farm-based indicator of impact.

There are numerous approaches for analysing macrofaunal data including univariate and multivariate techniques. Multivariate assessment of community structure uses the numbers of species and abundance of individuals in conjunction with the species identities to distinguish community patterns. Therefore the results of such techniques are inherently more representative of the true community distribution and were included as the benchmark against which all other techniques were evaluated. However, other, simpler forms of analysis were also assessed. The Abundance – Biomass comparison (ABC) method (Warwick, 1986) has been shown by Ritz et al. (1989) to be a useful method for evaluating conditions associated with cage aquaculture in Tasmania. The analysis for this technique is fundamentally simpler than that for multivariate analysis and has the advantage of specific impact levels being associated with the particular curve profiles. But this technique does require biomass information for all of the identified species and therefore is, once again, more appropriate as a validation technique rather than a farm-based method. There are many univariate diversity measures which have been applied to assessment of environmental impact and several such indices have already been applied to the assessment of cage aquaculture impacts (Johannessen et al., 1994; Henderson and

Ross, 1995; Drake and Arios, 1997; Lu and Wu, 1998). In particular species richness, total abundance and the Shannon Index (Shannon and Weaver, 1963). These indices were also evaluated in the light of a recent draft report to the Tasmanian state government which indicated that particular levels of these indices could be related to specific environmental effect levels (Crawford et al., unpublished data).

1.4 Objectives of Study

The suite of assessment techniques selected for further investigation from examination of the literature included: macrofaunal assessment, measurement of sedimentation rates, determination of organic carbon and measurement of sediment redox potential. Two farm sites in southern Tasmania were selected to broadly represent the range of conditions encountered in the State. All the selected techniques were then evaluated to determine the range of their spatial variability at each of the study sites over a range of sampling stations chosen to be representative of conditions within and beyond the lease boundaries. The techniques were also assessed to determine whether any modifications could improve their farm-based application. The methods selected after this stage were then evaluated over 18 months to determine their sensitivity to the temporal variability of the reference stations and the changes in impact associated with ongoing farm practices. At the completion of the field studies the techniques were considered in relation to their performance as farm-based techniques according to 3 simple guidelines,

1) accurate indication of environmental conditions,
2) simplicity / ease of use and
3) robustness.

From the commencement of this project it was understood that one possible outcome might be an inability to identify a single technique suitable for application in farm-based assessment. In this case it would be likely that macrofaunal community assessment would remain the most reliable means by which enrichment effects could be detected. Consequently it was determined that one other way in which this study could benefit farmers was by evaluation of the level of taxonomic discrimination required for reliable detection of farm impacts. Full macrofaunal community assessment at species level is very expensive as it is both time consuming and

requires a significant level of expertise. The aquaculture industry in Tasmania is currently required to undertake benthic infaunal assessments only to family level as part of the lease conditions. Many studies have been undertaken indicating that family level is sufficient to determine the pattern of anthropogenic impact (Warwick, 1988a and b; Ferraro and Cole, 1990; Ferraro and Cole, 1992; James et al., 1995; Somerfield and Clarke, 1995). In fact, several studies have gone as far as to suggest that, for sublittoral soft sediment benthic macrofauna, little information is lost in multivariate assessment by identification up to phylum level (Ferraro and Cole, 1990; Gray et al., 1990; Warwick 88c; Warwick et al., 1990). Warwick (1988) suggested pollution events affect assemblages at higher taxonomic level than natural disturbances (ie above species level) and therefore that assessment at a level above species should detect human influence. James et al. (1995) found that multivariate analysis techniques were the most resilient to increases in taxonomic level. Consequently, the final component of this study is assessment of the effects on the data set of increased taxonomic level and evaluation of subsets of the data. Warwick (1993) and James et al. (1995) suggest that it may be more appropriate to collect more samples with the time/money thus saved. Any savings in time and effort would be of considerable economic benefit to farmers and would therefore allow for more frequent assessment of environmental conditions.

In conclusion the four main objectives of the present study can be summarised as follows:

- To assess a range of proven techniques for evaluation of environmental impact, spatially and temporally under Tasmanian aquaculture conditions, with respect to their suitability for use as farm-based monitoring tools.

- To evaluate any differences in the results from the selected techniques at two locations within Tasmania with very different environmental conditions in order to determine the extent to which location might affect the results.

- Where possible to refine these techniques and, from the results, recommend a farm-based monitoring protocol.

- To examine the level of taxonomic discrimination necessary for reliable detection of farm impact and assess the effects of changing taxonomic level.

Chapter 2 -
Assessment of Spatial Variability in Benthic Community Structure and Sediment Condition: Preliminary Evaluation of Selected Monitoring Techniques.

2.1 Introduction

Monitoring of the environmental status of fish farm leases makes good sense in the context of sustainable management. Even with careful site selection and the best possible environmental conditions, careful and responsible management of the aquaculture operation still has an essential role to play in mitigating any environmental impacts. The duration of stocking, stocking density and magnitude of feed input all have a direct bearing on the amount of organic material deposited on the seabed. If farm managers can determine the extent of environmental degradation beneath their cages then this information will assist them in deciding when to move cages which in turn, when integrated into the overall farm management plan for rotation of cages within the site, will allow optimal usage of the lease area. Consequently farmers need simple tools which they can employ to assess sediment health.

There are many biotic and abiotic factors which could be measured either independently or in combination and which would give indications of the sediment health. However, it is the application of techniques for farm-based use which is of interest in this study. In chapter 1 a variety of commonly applied techniques for evaluation of environmental impact were reviewed, and several were identified as having potential for farm-based application. The suitability of a technique for farm-based use was determined by whether it could be easily employed on site by capable technical staff, ie. those approaches which were simple, robust and reliable. The techniques selected after the initial review included macrofaunal assessment, measurement of sedimentation rates, determination of organic carbon and measurement of sediment redox potential.

Assessment of the macrobenthic community structure is generally considered the most sensitive means of determining environmental impact. Weston (1990) perhaps highlighted this most clearly when he observed that the fauna are sensitive at enrichment levels undetectable with gross chemical measures and that the fauna reflects the integration of effects, which in combination are more severe than that reflected by each single event. Although evaluation of the full community structure is not an approach that could be undertaken "on farm" it was decided that the results of species based assessment could provide several other possible options for farm based environmental assessment, ie. readily identifiable indicator species or particular community attributes, which may be employed as farm based techniques.

Cage culture of fish generates large amounts of particulate organic waste. Beveridge, (1996) proposed that the amount of carbon deposited under fish farms was at least an order of magnitude greater than that at reference sites. Other authors have indicated that the amount could be much greater, in the region of 1-3 orders of magnitude higher at farm locations (Brown et al., 1987; Hall et al., 1990, Hansen et al., 1990; Ye et al., 1990). In their investigation of fish-farming effects in Scotland, Brown et al. (1987) detected a clear relationship between sedimentation rate and changes in faunal structure, however in other studies this relationship has not been so clear. Sedimentation rate has been employed in several ways as an indicator of environmental impact. In British Columbia, Canada, the Ministry of the Environment requires measurement of sedimentation rate at sites where depths prohibit diver surveys to indicate the degree of impact (B.C. Ministry of Environment, 1988). There are several commonly used predictive models which require estimation of sedimentation to calculate the effects of deposition (Gowen and Bradbury, 1987, Gowen et al., 1988). The model devised by Gowen et al. (1988) linked the sedimentation rate to the rate at which H_2S may be formed and released from the sediments. Sedimentation rate was also an important component of the recovery model developed by Woodward et al. (1992) in their study of salmon farming in the Huon estuary, Tasmania. Hence, measurement of sedimentation rate can be used to give an indication of how much material is being deposited on the seabed as a result of the farming activity and therefore may provide a very simple means to estimate the overall effect of the farm.

Although the overall effect of farm input may be influenced by site specific environmental conditions (ie. current flows, tidal range and frequency, depth, degree of exposure and farming protocols etc), the organic matter content of the sediment has been shown to relate directly to the level of farm inputs (Hall et al., 1990; Holmer, 1991). It was suggested in both of these papers that temporal changes in the sediment's organic matter content reflect the sediment's capacity to assimilate this material. This in turn suggests that some measurement of organic matter would be an extremely useful means of determining localised cage impacts. One of the simplest ways to measure organic matter content is by measurement of loss of organic matter on ignition (LOI), (Greiser and Faubel, 1988).

The final technique suggested from the review in chapter 1 was some means of measuring the redox potential of the sediment. Measurement of the redox potential can be used to evaluate the level of oxygenation of the sediments and more specifically to determine the position of the oxic / anoxic boundary layer or redox potential discontinuity (RPD) depth. Therefore evaluation of redox potential should give a direct indication of sediment health and also, in temporal comparisons, an indication of degree of degradation. Several studies have indicated that they found redox to be a useful measure of sediment condition (Pearson and Stanley, 1979; Jorgensen and Revsbech, 1985; Brown et al., 1987; Weston, 1990; Hargrave et al., 1993; Karakassis, 1998). Pearson and Stanley (1979), in their study on the effect of pulp-mill effluent, showed that redox was a good measure of the varying organic enrichment levels. Wildish et al. (1990) related particular redox levels to the major aerobic and anaerobic respiration processes, (Table 2.1). Gowen and Bradbury, (1987) went on to relate specific carbon loadings to changes in redox potential, suggesting that an organic carbon load greater than 7kg m^{-2} yr^{-1} can alter sediment redox potential by up to –200mV. Brown et al. (1987) also noted marked reductions in redox potential in areas within fish-farms associated with high organic input, and furthermore recorded seasonal variations in these redox potential levels, with values being lowest over the summer period. In Tasmania, Woodward et al. (1992), in a study of fish farms in the Huon estuary, recommended measurement of redox potential as a possible indicator of recovery; defining recovery as the point at which anoxic conditions were replaced by oxic conditions.

Table 2.1 Major aerobic/ anaerobic processes and related redox potential levels (Wildish et al., 1990).

Type	Electron Acceptor	Products	Redox Potential (mV)
Aerobic	O_2	H_2O	>0
Anaerobic			
- denitrification	NO_3^-	NO_2^-, NH_4^+, NH_3, N_2	0 to –150
- sulphate reduction	SO_4^{2-}	H_2S, HS	-150 to –200
- methanogenesis	CO_2	CH_4	-250 to -300

The two sites selected for the present survey were chosen because of their very different environmental conditions and because they broadly represent the environmental extremes of the Tasmanian aquaculture environment. It was felt that for a technique to be really useful to the industry it had to be applicable in all areas where farming was undertaken.

The physical, chemical and biotic parameters outlined above have clearly been shown in previous studies to be useful indicators of environmental degradation and consequently in the spatial survey these techniques were used to assess environmental conditions and sediment health across the entire lease area at each of the chosen farm locations. The three principal aims associated with the spatial survey were;

a) to assess the overall differences in physical and biotic conditions between the two farm sites,
b) to determine the spatial variability of impact within the lease areas and to quantify this impact and,
c) to link the two previous objectives by using the results to make a preliminary assessment of the usefulness of the various techniques both for determining impact and for use as farm based tools.

2.2 Materials and Methods

2.2.1 Site Location

The two study sites chosen were very different in their physical nature. Badger Cove, Nubeena on the Tasman peninsula (Figure 2.1) is a relatively exposed, marine site

whilst Meads Creek, situated in Port Esperance near the mouth of the Huon estuary is more sheltered and subject to greater salinity variations as a result of variable river flow. Both farms are owned and operated by Tassal Ltd. Samples for the spatial survey were collected from Nubeena on 13th December and from Meads Creek on 16th December 1993.

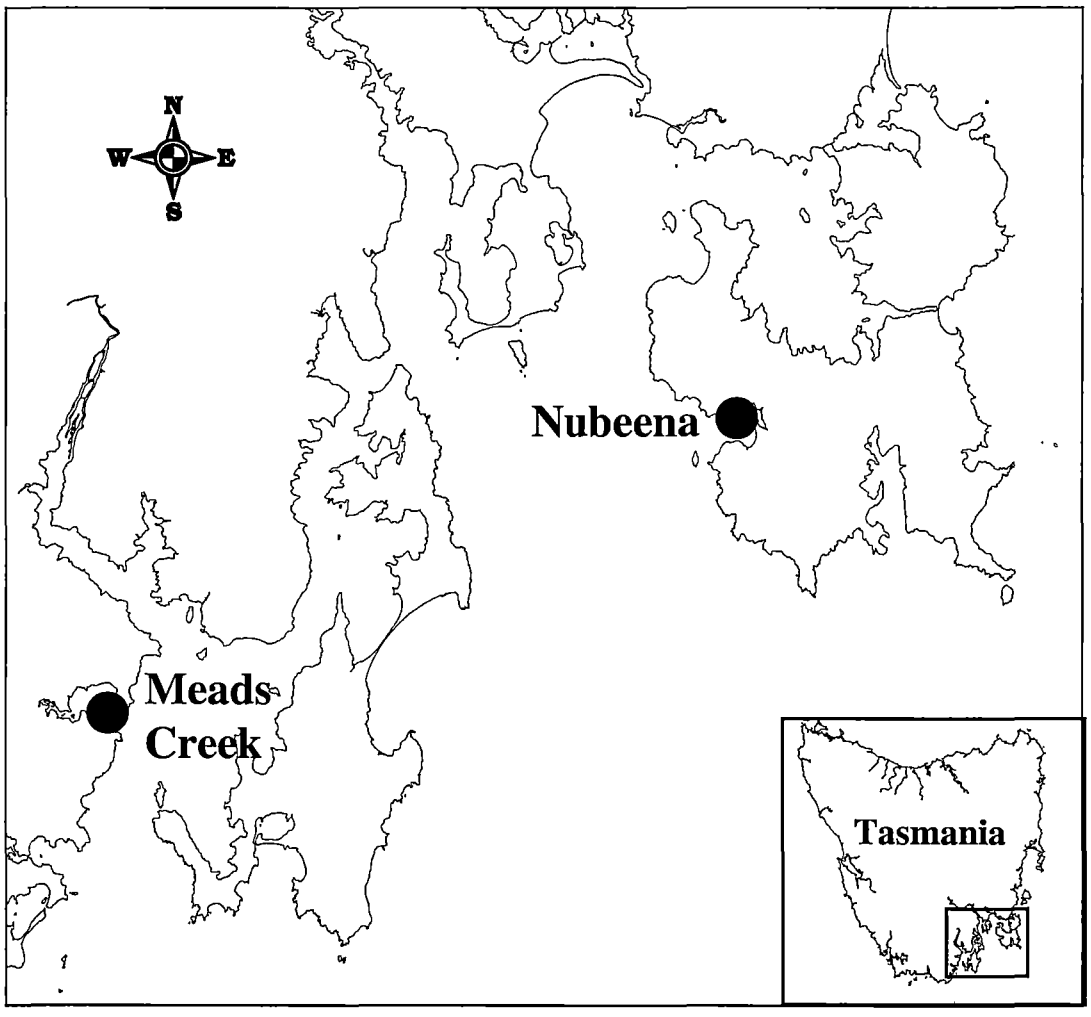


Figure 2.1 Locations of the two sampling sites in SE Tasmania.

The choice of the sampling stations was made to provide an overall picture of the lease and conditions immediately adjacent to the lease boundaries. Consequently a sampling protocol was developed to cover the length and breadth of the lease, sampling both under and between cages.

The Nubeena lease (Figure 2.2) has been in operation since 1980 when it was set up as an experimental site to trial the culture of rainbow trout. In 1986 the operation

became a commercial venture and the culture of Atlantic salmon (*Salmo salar*) began and has continued at the site until the present. (DPIF, 1996a)

The farm area covers approximately 10.9 ha, with water depths in the range of 10-20m (Table 2.2). Figure 2.2 shows the depths recorded for each of the sampling stations in this study. Salinity at the site varied between 32-33 ppt and temperature was in the range of 8-17 °C. Current measurements recorded for the area indicate speeds of 2-10 cm s^{-1} for 45% and 0 cm s^{-1} for 51% of the readings (TAFI, unpublished data). However, infrequent storm events do occur at this site and these can produce significant scouring of the lease area (pers. obs.).

Table 2.2 Depths and relative locations of sample stations in spatial survey at Nubeena.

STATION	POSITION	DEPTH (m)
1	Cage	13.2
2	Cage	13.1
3	Between two cages	13.0
4	Between cage and western boundary	13.1
5	Between two cages	12.4
6	Between cage and inner boundary	12.9
7	Southern reference	13.4
8	Eastern reference	14.0
9	South eastern reference	19.0

Cages at the Nubeena site were of a rectangular steel structure, measuring 8m by 12m and linked in groups of 2 or 3. The two cages monitored in this study had been continuously stocked for approximately 3 months prior to sampling.

The farm at Meads Creek (Figure 2.3) has been in operation since 1985 and is a fairly large farm operation (14.32 ha) which has had continually increasing production since the site was first developed. There is also a land-based plant adjacent to this site which at the time of sampling processed all the fish produced by Tassal, as well as some from other salmon farming companies, producing approximately 65% of the salmon in Tasmania (DPIF, 1996b). The liquid effluent from this plant is pumped out to sea.

Depth within the lease was highly variable (Table 2.3), ranging from 10-35m, however the cages were generally situated in 20-30 m depth. Current flow in the

lease area has been recorded as between 5-20 cm s^{-1} for greater than 80% of the time and water temperatures ranging between 10-18 °C. There was evidence of a halocline at the site at several times during the sampling programme and a thermocline formed when the freshwater on the surface was considerably cooler than the underlying seawater. Salinity could therefore fluctuate at the surface and within the first few metres from fully marine to almost freshwater. Although salinity was not recorded at the seabed, it is unlikely that the deeper waters would experience such a variation.

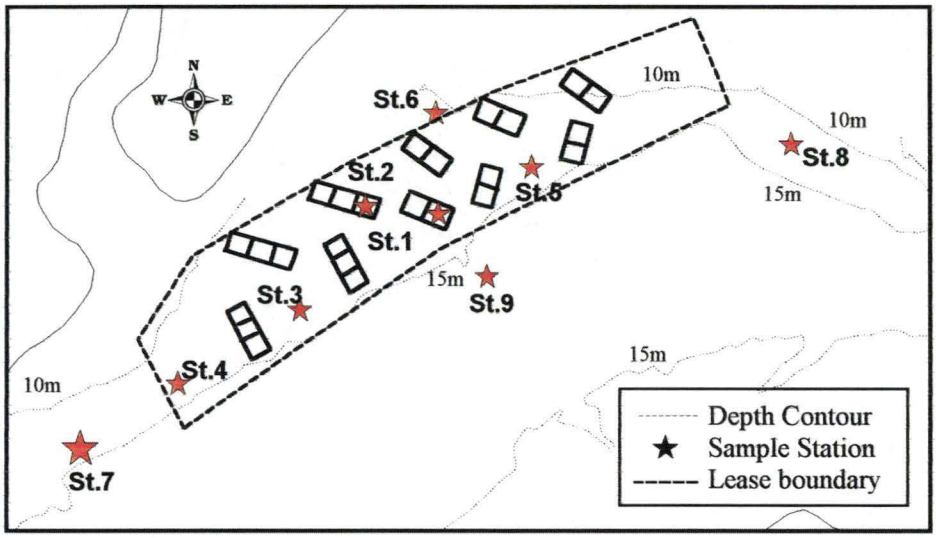


Figure 2.2 Map of Badger Cove, Nubeena showing the location of the lease area, the sampling stations, the cage positions and depth contours (m).

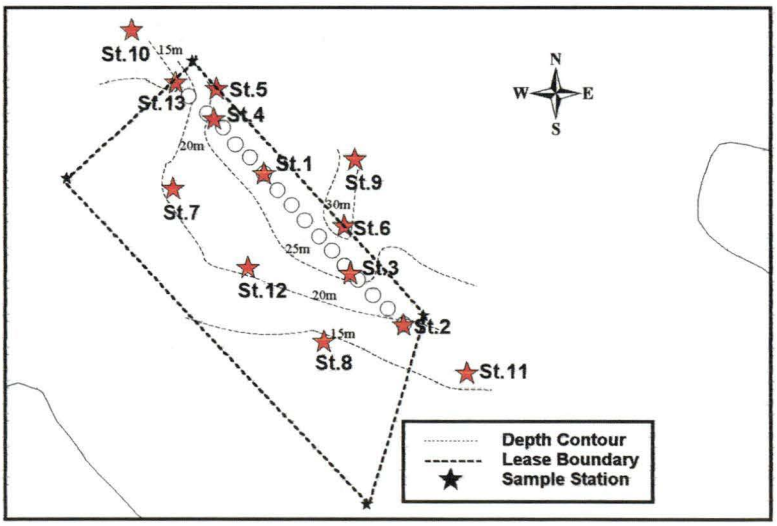


Figure 2.3 Map of Meads Creek showing the location of the lease area, the sampling stations and the cage positions.

The cages at Meads Creek were of the polar circle design, approximately 22 m in diameter and attached individually along a main mooring line. The cages associated with station 1 had been stocked for only a week prior to the commencement of this study whereas station 2 had been stocked for approximately 3 months prior to sampling.

Table 2.2 Depths and relative locations of sample stations in spatial survey at Meads Creek.

STATION	POSITION	DEPTH (m)
1	Cage	26.5
2	Cage	19.5
3	Between two cages	26.5
4	Between two cages	26.5
5	Offshore Boundary	26.5
6	Offshore Boundary	31.5
7	Inshore – behind cages	21.5
8	Inshore – behind cages	14.0
9	Offshore reference	30.5
10	Northern reference	12.0
11	Southern reference	17.5
12	Inshore – behind cages	21.5
13	Between cage and boundary	14.0

2.2.2 Determination of replication level

A preliminary study was conducted to determine the level of replication required to adequately represent the variability of the community structure. Sample replication is generally deemed to be sufficient when the number of species represented are no longer markedly increased by the inclusion of further samples (Brower et al., 1990) or when greater than 75% of the fauna has been represented. Consequently the number of replicate samples required for each of the study sites was determined by plotting the cumulative number of species retained on a 1mm sieve against both the cumulative number of replicates (species-sample curve) and cumulative sample area (species-area curve).

At Nubeena sorting of ten replicates recovered a total of 88 species (Appendix 2.1). The cumulative percentage curve began to level off after seven replicates, a cumulative sample area of 0.4725 m^2, and from this point only four further species were added. The first five replicates (sample area of 0.3375 m^2) resulted in recovery

of 70 species, 79.5% of the total. Four replicates still resulted in better than 70% recovery (Appendix 2.1).

At Meads Creek assessment of the number of replicates (Appendix 2.2) indicated that sorting ten replicates resulted in 67 species being recovered. The species-sample curve begins to level off after five replicates, at a cumulative sample area of 0.3375 m^2, at which point 58 species had been identified, i.e. 86.6% of the total species recovered (Appendix 2.2). It was therefore determined that five replicates at each site would be sufficient to evaluate the benthic community differences as a result of organic enrichment from fish-farms.

2.2.3 Granulometry

The samples for the granulometric assessment were obtained either by diver or, where depths prohibited diving, by using a Craib corer. The samples were collected in core tubes 250mm long and with a diameter of 45 mm. The top 40 mm was collected from each core for sediment particle size analysis. In the laboratory the samples were rinsed with a solution of sodium hexametaphosphate ($Na(PO_3)_6$), which prevents the sediment particles from sticking together when dry, after which the samples were dried at 100°C overnight. After drying, each sample was shaken through a graded sieve stack. The sieve sizes used were 2 mm, 1 mm, 500 μm, 250 μm, 125 μm, 63 μm and a pan was placed at the bottom of the sieve stack to collect the fraction smaller than 63 μm. The sediment retained on each sieve was weighed and this weight was then expressed as a percentage of the total sample weight. It was found after commencing the analysis of the sediment samples that some samples were particularly fine, and that the treatment with sodium hexametaphosphate was not sufficient to prevent the particles binding when dried, consequently it was necessary to wet sieve these samples. In these instances the samples were still treated with sodium hexametaphosphate as previously described but were then passed through the sieve stack whilst still wet. The fractions retained were then rinsed into trays and each fraction dried at 100°C and weighed in the manner previously described. The results are depicted graphically as a cumulative percentage curve plotted against Φ (phi) size, ($-\log_2$ particle diameter in mm).

2.2.4 Measurement of Sedimentation Rate

Sedimentation collectors were set up at all sampling stations and were emptied fortnightly. Traps were located approximately 1.5 m above the sediment surface and their positions noted with surface marker buoys. Each sediment trap comprised a 1 litre plastic jar which had been designed to be screwed on to the base of a 250 mm diameter funnel. The bottom of each funnel was covered with mesh to prevent large invertebrates and fish getting into the collection vessel. A large piece of rock salt was also placed in each vessel to deter organisms from settling in the containers. The containers were changed fortnightly and the contents of the sediment traps were washed through pre-weighed filter paper cones. The sediment collected was dried (overnight 100°C) and the weights recorded.

2.2.5 Measurement of Organic Matter

Total organic matter was determined by loss on ignition (Greiser and Faubel, 1988). After the redox measurements were completed the top 40 mm of each core was collected in a zip lock bag and frozen. In the laboratory the sample was homogenised and a sub-sample of approximately 25-30 g was taken for total organic matter determination. This sample was oven dried overnight at 60°C, weighed and then transferred to a muffle furnace for 2 hours at 480°C after which the samples were re-weighed. The difference between the oven dried and final furnace "ashed" weights was calculated. The results were expressed as the percentage total organic matter and differences between the sample stations were assessed with one-way analysis of variance (ANOVA).

2.2.6 Measurement of Redox Potential

Measurement of the redox potential (Eh) was carried out at the time of sampling using a method based on that of Pearson and Stanley (1979). At each of the sampling locations, three replicate samples were collected by diver. Upon arrival at the surface the cores were placed in a specially constructed holder (figure 2.4) which supported both the core tube and redox probe thus enabling stable and precise measurements to be taken at prescribed depths.

Measurement was first made of the Eh of the water overlying the sediment sample. The core tube was then positioned in the probe holder so that the tip of the probe was

located just at the sediment sample surface and a reading taken at this point. The probe was then gently wound down through the core sample with readings being taken at 5mm intervals until either the redox discontinuity depth was reached (mV reading + calibration adjustment + Ag/AgCl reference correction = zero) or to a maximum depth of 50 mm. If the RPD level was not reached by 50 mm an RPD depth of 55 mm was assigned. The redox probe reading was calibrated in a standard reference solution between each core sample and adjustment made to the meter readings for any deviations from these calibration values. Redox potential values were adjusted to the standard hydrogen electrode by addition of the Ag/AgCl reference correction values for standard potential as shown in table 2.4.

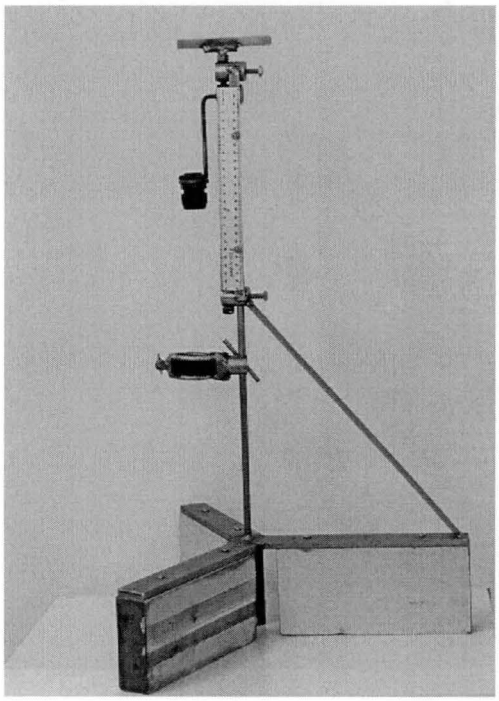


Figure 2.4 Redox Probe holder.

Table 2.4 Standard potentials for Ingold Ag/AgCl reference electrodes. Copied from Ingold, 1982.

Temperature (°C)	Standard Potential - Ag/AgCl 3mol/l
5	220.9
10	217.4
15	214
20	210.5

2.2.7 Macrofaunal Analysis

The samples at Nubeena were collected by diver using at box quadrat, 225 mm wide and 300 mm long giving a sample surface area of 0.0675 m^2. The quadrat was pushed into the sediment to a specified depth (100 mm) and the contents of the quadrat were transferred into self-sealing plastic bags. On the basis of the results of the sieve size and replication trials five replicates were taken for macrofaunal analysis at each sample location. The bagged samples were taken to the surface where they were passed over a 1mm sieve on the boat. All the material retained on the 1mm sieve was decanted into an appropriately labelled 1 litre sample storage bottle and the contents fixed by adding sufficient neutral buffered formalin to obtain a concentration of 5-10% (v:v).

At Meads Creek the depths of many of the sites prohibited diver sampling, consequently at these sites samples where collected using a modified Van Veen grab, surface area of 0.0675 m^2. Samples were then processed as previously described.

The samples were transferred to the laboratory where each sample was sorted to remove the macrofauna. The fauna was identified to the lowest possible taxonomic level and the number of individuals in each grouping counted and weighed.

2.2.8 Statistical Analysis

One-way ANOVA was conducted on data for diversity measures (total abundance, number of species and Shannon diversity index) and physical / chemical factors to determine whether significant differences existed between the sample stations at each site. Further resolution was achieved by the application of Tukey's Highest Significant Difference post hoc tests.

Patterns in the species community data were identified by means of agglomerative hierarchial cluster analysis and these patterns were then displayed both as dendrograms and ordination plots using multi dimensional scaling (MDS). One way multivariate analysis of similarities (ANOSIM) was used to assess differences between sample stations in the species and biomass data and to determine if these were significant. The relative contribution of each species to the average similarities of the stations (groups) and average dissimilarities between stations (groups) was calculated and the results expressed as percentages (SIMPER). These results were

then used to determine if any particular species were indicative of the patterns identified by cluster and ordination analyses. Finally the environmental and biotic data sets were compared to determine how well they correlated (RELATE) and whether the community patterns that were observed in the biotic data could be explained in terms of the physical chemical parameters (BIOENV). All the multivariate analyses were conducted using the Plymouth Routines in Multivariate Ecological Research (PRIMER) software package.

The method of Abundance-Biomass Comparison (Warwick, 1986) was applied to the macrofaunal data from both Nubeena and Meads Creek in order to verify the evaluation of impact suggested by the multivariate comparisons. The ABC method is a graphical technique whereby the cumulative abundance and biomass of all the species recovered are plotted against species rank, and the level of community disturbance indicated by the relative positions of the two plots. Figure 2.4 shows hypothetical curves indicative of unimpacted, moderately impacted and highly impacted conditions. The curve profiles for undisturbed conditions show the biomass curve lying above the abundance curve, indicating that there are no numerically dominant species within the community but that the biomass is dominated by a few large bodied individuals. When the community is disturbed the large dominant organisms are progressively eliminated and the community becomes increasing dominated by small bodied, abundant, opportunistic species. Consequently, under moderately impacted conditions, the biomass curve will be lower than for unimpacted conditions whilst the abundance curve will be higher resulting in the two curves lying close together, sometimes overlapping. With a more severe impact the dominance of the small bodied opportunists becomes more marked and the abundance curve will assume a position high on the graph whilst the biomass curve will assume a low position. Under highly impacted conditions the number of species recorded overall will be reduced and therefore the curves will be shorter than those encountered under unimpacted conditions.

Each of the cumulative dominance plots can be condensed to a single summary statistic (Clarke, 1990). This W-statistic is determined by calculating the difference between the two curves (B-A) and then summing these values for all the samples. The resultant summary statistic will take values in the range –1 to 1, with a value of around 1 representing conditions where the abundance across species is relatively

even but the biomass is dominated by a single/few species (ie unimpacted conditions); a W-statistic approaching –1 would be attained under the opposite conditions (impacted). The community structure under conditions of intermediate impact will tend to give W-statistic values near zero. Calculation of the W-statistic allows univariate analyses to be applied, ie. ANOVA, to determine if significant differences exist between the communities represented by the data.

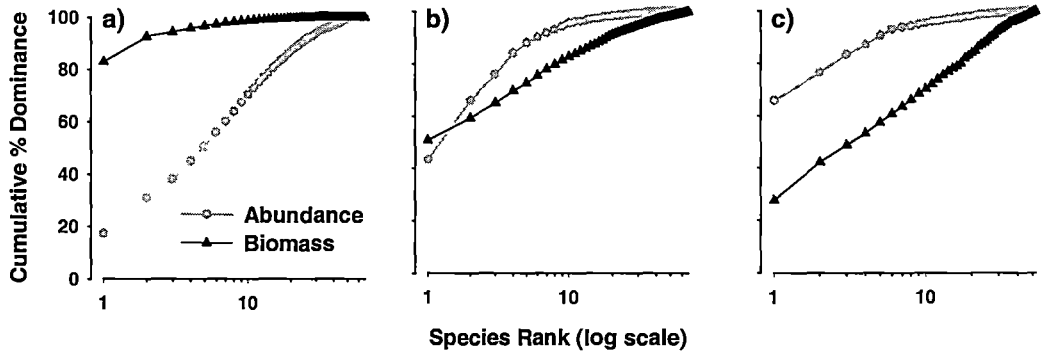


Figure 2.4 Hypothetical cumulative dominance curves for species abundance (◎) and biomass (▲), indicating a) undisturbed, b) moderately disturbed and c) highly disturbed conditions. (after Warwick and Clarke, 1994).

2.3 Results

2.3.1 Granulometry

The grain size distribution results for each station at Nubeena (Appendix 2.3) indicated that, generally, the sediments could be classified as fine-very fine sand (Wentworth scale; Holme and McIntyre, 1984). The sediments at Nubeena were generally moderately to poorly sorted and tended to be skewed towards larger grain sizes (Appendix 2.4). Most of the variability in the sediments was as a result of variations in these larger grain size fractions. Station 9, the deepest station, furthest from shore (Figure 2.2), had the highest percentage of silt/clay (Appendix 2.3).

At Meads Creek, particle sizes were much finer than those recorded for Nubeena. According to the distribution data, the sample stations could be divided into two main groups (Appendix 2.5). Stations 8, 10 and 11 were slightly coarser than the remaining stations and could be classified as primarily fine-very fine sand. Whilst stations 1, 4, 5, 6, 7, 9, 12 and 13 displayed finer sediments (greater than 50%

silt/clay) and therefore could be classified as silt/clay. The remaining two stations (2 and 3) were intermediate to these two conditions. Overall, the sediments from Meads Creek were poorly sorted and skewed towards the finer grain sizes (Appendix 2.6).

2.3.2 Sedimentation Rate

The sediment traps were spectacularly unsuccessful; the traps were very susceptible to wind and tidal currents, many upturning on high and low tide cycles and after one storm event at Nubeena all containers were lost. The surface marker buoys proved to be a continual attraction to both unwitting farm hands and, at the reference sites, to local fishermen and sailors who would lift them out of curiosity. Consequently the contents were frequently discarded or the containers were not flooded before redeployment and were found floating upside down. Several alternative designs were tried (weighted containers and fixed on line containers) and appropriate warnings were attached to the marker buoys. However, there was too much uncertainty associated with the data that was recovered to apply it in any analyses.

2.3.3 Organic matter

Organic matter levels at Nubeena were generally low (less than 4%, Figure 2.5). ANOVA (Table 2.4) showed that there were indeed significant differences between the stations, and subsequent post hoc testing (Appendix 2.7) identified that cage station 2 was significantly different to stations 4, 8 and 9. However, the pattern of organic matter levels within the site (Figure 2.5) also suggest that the organic matter level associated with the cage at station 2 was markedly higher than that at the other cage station, 1.

Table 2.5 ANOVA for organic matter levels for all stations in the spatial survey, Nubeena.

	df	MS	F-ratio	P
Station	6	1.427	14.585	<0.001
Error	9	0.098		

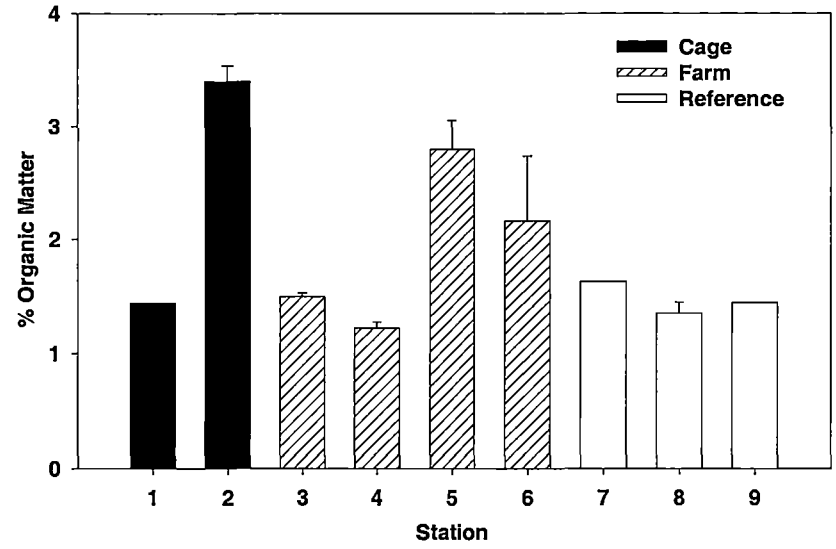


Figure 2.5 Percentage organic matter content (+ s.e.) for Nubeena spatial survey stations.

Overall, the organic matter levels recorded at Meads Creek were approximately five times higher than those recorded at Nubeena. Stations 8 and 10 appeared to have lower organic matter levels (Figure 2.6) than the other sample stations. Particularly high levels (greater than 16%) were recorded at stations 1 and 9, although stations 4,

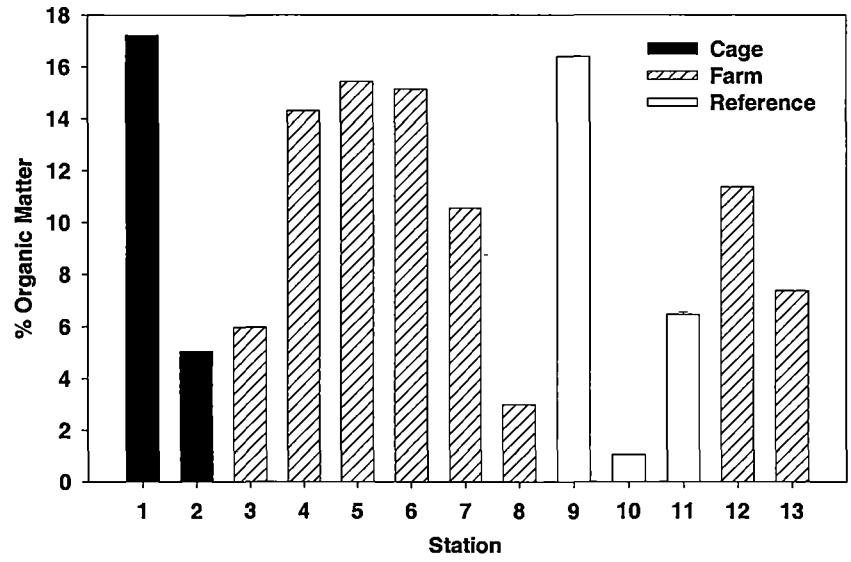


Figure 2.6 Percentage organic matter content (+ s.e.) for Meads Creek spatial survey stations.

5 and 6 were all also comparatively high (greater than 14%). Unfortunately, due to a storage problem only a single organic matter sample was available for analysis from

several sites and therefore further statistical evaluation of the results was not possible.

2.3.4 Redox potential

The redox profiles for the spatial survey stations at Nubeena are shown in figure 2.7. The sediment at station 2 was anoxic at the surface. The redox values for station 1 also declined rapidly with depth and the RPD depth at this station was located between 15 and 20mm. The redox profile for the remaining stations appeared to be similar and approached zero at approximately the same depth.

Plotting redox potential values for the sediment surface only (Figure 2.8) indicates that stations 1 and 2 (the two cage associated locations) tend to differ from the

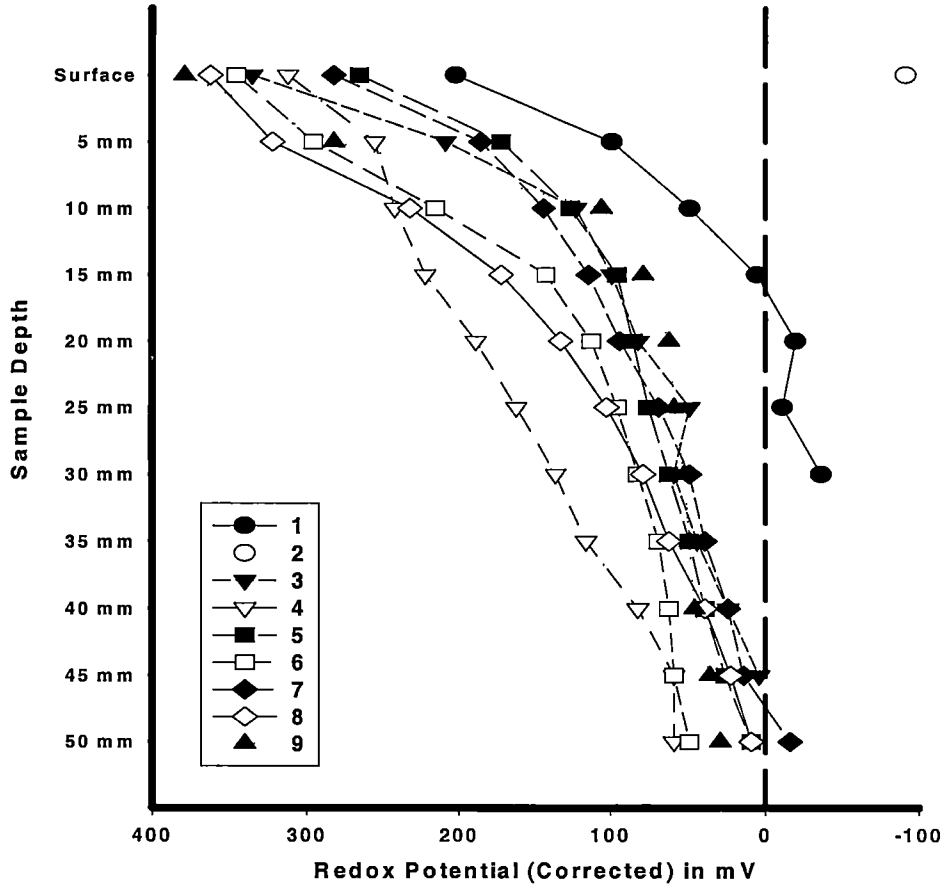


Figure 2.7 Redox potential measures for spatial survey stations at Nubeena (values corrected for standard hydrogen reference electrode).

remaining stations. However, while ANOVA (Table 2.6) indicated that there were significant differences between the stations, the results of the pairwise comparisons (Appendix 2.8) showed that only station 2 differed significantly from other stations.

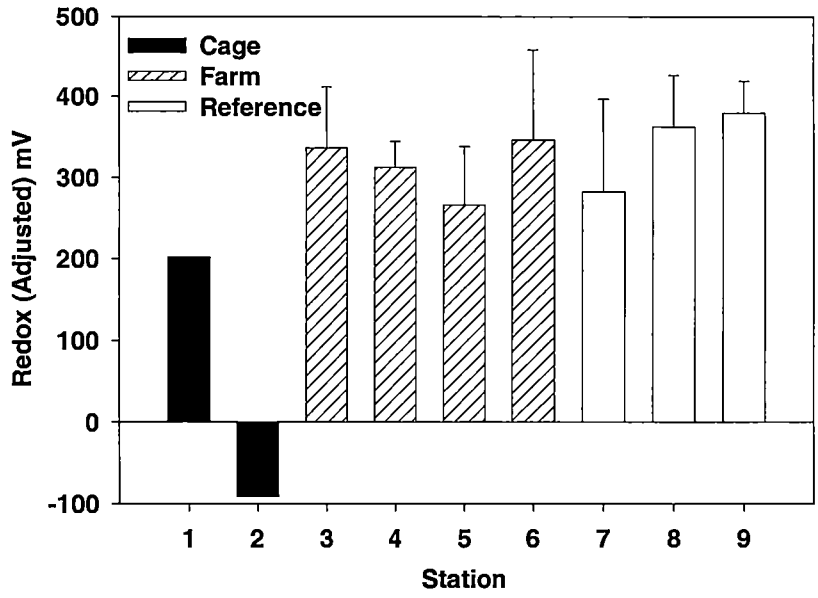


Figure 2.8 Sediment surface redox potential (+s.e.) for spatial survey stations at Nubeena (values corrected for standard hydrogen reference electrode).

Table 2.6 ANOVA for sediment surface redox potential for spatial survey stations, Nubeena.

	df	MS	F-ratio	P
Station	8	62687.037	10.485	<0.001
Error	18	5978.704		

ANOVA (Table 2.7) indicated significant differences between the Nubeena stations in respect of the RPD depths (Figure 2.9) and pairwise comparison (Appendix 2.9) showed that the RPD depths for stations 1 (~18 mm) and 2 (0 mm) were significantly shallower than those of all other stations (>40 mm). The RPD level for station 2 was also significantly shallower than that at station 1, being at the sediment surface.

As at Nubeena, the results of the redox potential assessment at Meads Creek also showed significant differences between the stations in the spatial survey. The redox profile curves shown in figure 2.10 clearly distinguish stations 1 and 4. The data indicate that both stations 1 and 4 were anoxic at the sediment surface. The profile

for station 2, the other cage station included in the spatial survey, was not markedly different from the remaining plots.

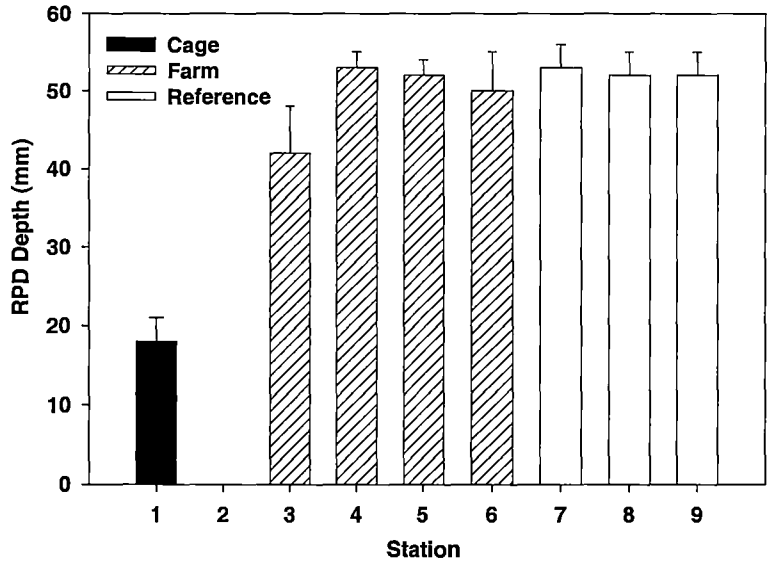


Figure 2.9 Redox potential discontinuity (RPD) depths (+s.e.) for spatial survey stations at Nubeena (values corrected for standard hydrogen reference electrode).

Table 2.7 ANOVA for redox potential discontinuity depths for spatial survey stations, Nubeena.

	df	MS	F-ratio	P
Station	8	1071.514	29.740	<0.001
Error	17	36.029		

ANOVA (Table 2.8) indicated that there were highly significant differences in sediment surface redox (Figure 2.11) between stations. Pairwise comparison (Appendix 2.10) confirmed that stations 1 (-28 mV) and 4 (-21 mV) had significantly lower surface redox levels than all other stations with the exception of each other and station 5 (162 mV). At both stations 1 and 4 the sediment was anoxic at the surface. Station 5 was also significantly different from stations 6, 7 and 8. Station 1 was one of the cage stations included in the spatial survey, station 4 was located between two cages and station 5 was on the lease boundary, adjacent to cages (Figure 2.3).

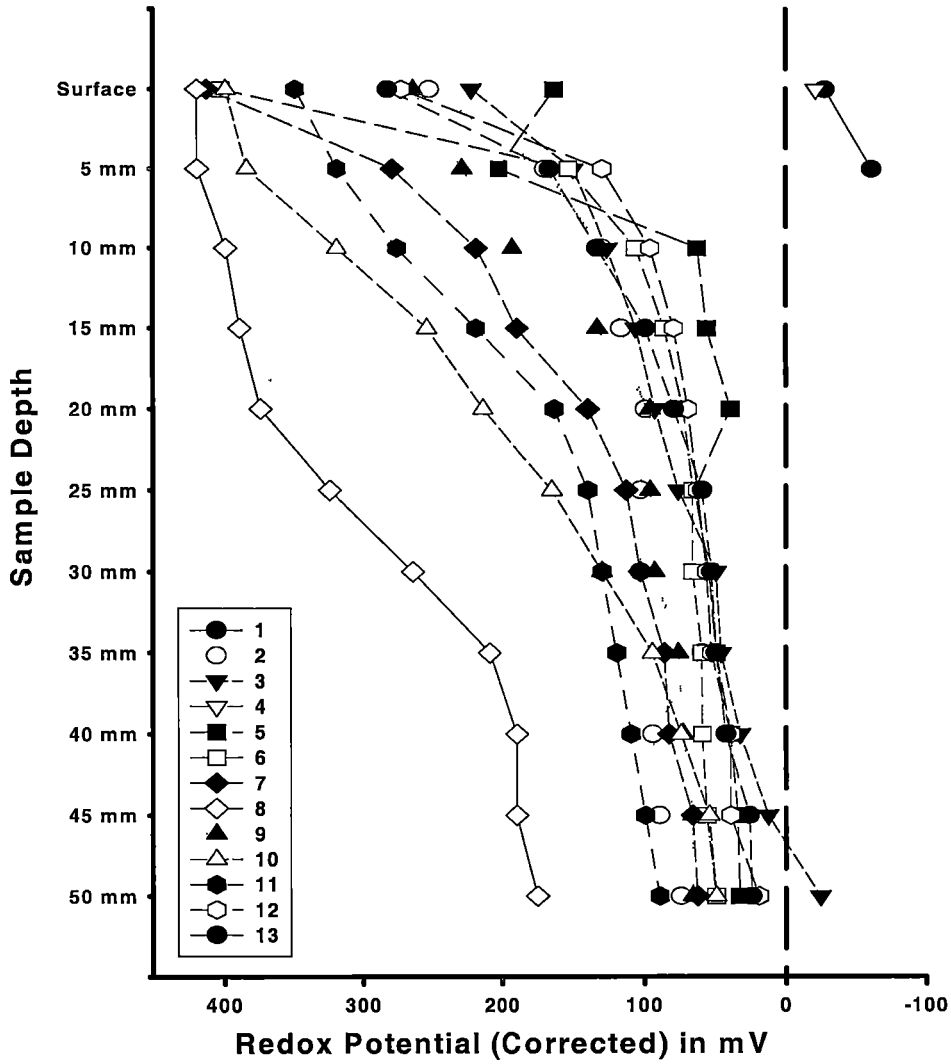


Figure 2.10 Redox potential profiles for spatial survey stations at Meads Creek (values corrected for standard hydrogen reference electrode).

Table 2.8 ANOVA for surface redox measures for the spatial survey stations, Meads Creek.

	df	MS	F-ratio	P
Station	12	63462.425	12.548	<0.001
Error	24	5057.639		

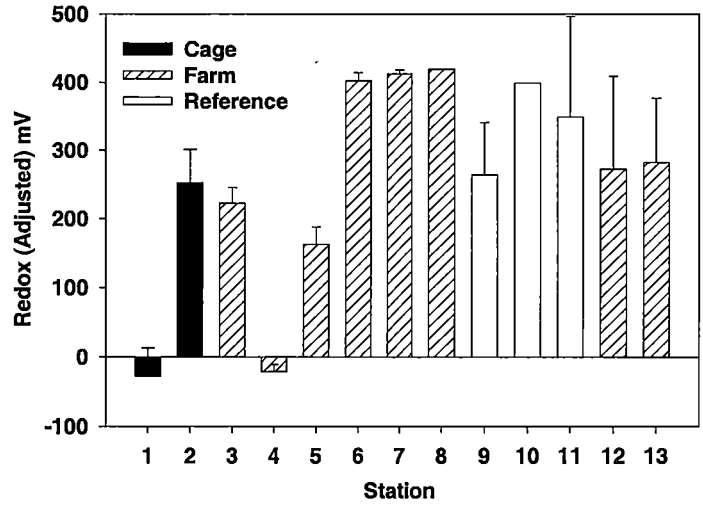


Figure 2.11 Sediment surface redox potential (+s.e.) for spatial survey stations at Meads Creek (values corrected for standard hydrogen reference electrode).

The RPD depth results for the spatial survey sample stations at Meads Creek are shown in Figure 2.12. Differences in the RPD depths between the stations were highly significant (ANOVA, Table 2.9), and pairwise comparisons (Appendix 2.11) indicated that these differences were as a result of stations 1 and 4. The RPD for station 4 was located at the sediment surface, and readings for all replicates were consistent resulting in a standard error of zero. RPD depth at station 1 was also markedly reduced (5 mm) relative to the remaining stations (>40 mm).

Table 2.9 ANOVA for RPD depth for the spatial survey stations, Meads Creek.

	df	MS	F-ratio	P
Station	12	1143.619	23.195	<0.001
Error	24	49.306		

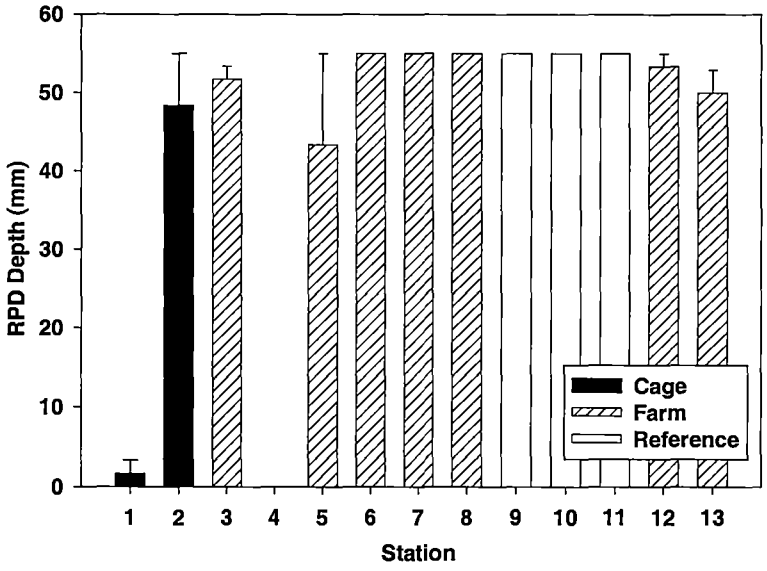


Figure 2.12 Redox potential discontinuity (RPD) depths (+s.e.) for the spatial survey stations at Meads Creek (values corrected for standard hydrogen reference electrode).

2.3.5 Macrofaunal Analysis

2.3.5.1 Multivariate Community Assessment - Nubeena

The first dichotomy resulting from cluster analysis of Nubeena community data clearly separated the two cage sites from the remaining stations at a similarity level of 25% (Figure 2.13a) with the two cages and the remaining stations forming groups with similarity levels of approximately 40%. Similarly MDS ordination (Figure 2.13b) clearly demonstrated separation of stations 1 and 2 from all others.

ANOSIM analysis of the individual station data (Appendix 2.12) suggested that stations 1 and 2 had significant differences in their faunal composition, in fact there were significant differences in the faunal communities between most stations. Furthermore, ANOSIM analysis of the a priori groupings of cage stations (1 & 2), farm stations (3, 4, 5 & 6) and reference stations (7, 8 & 9) indicated significant differences between all of those groups (Appendix 2.13).

SIMPER analysis (Table 2.10 a & b) indicated that the most characteristic species of the cage stations were *Capitella capitata* complex and *Malacoceros tripartitus* which contributed 47.6% and 32% respectively to the overall group similarity, between them accounting for approximately 80% of the similarity within this group.

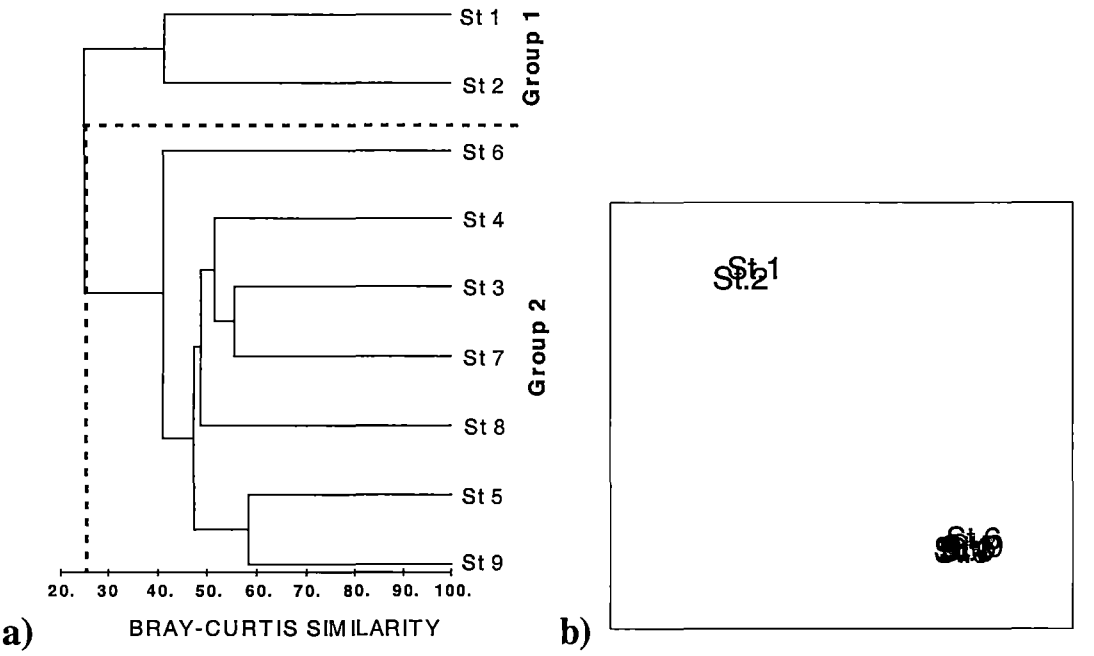


Figure 2.13 Multivariate output for species abundance data from the spatial survey at Nubeena a) Cluster analysis -Dendrogram b) MDS ordination plot (Stress=0.01). All data √√ root transformed and replicates combined.

The non-cage associated stations had a more diverse fauna, reflecting the broader range of conditions encountered at these sites. Consequently this group was not as clearly defined by any particular species, however there were several species which commonly occurred. The terebellid polychaete *Pista australis*, the ampharetid polychaete, *Phyllamphicteis* sp. (cf *foliata*), both selective deposit feeders, were amongst the more common species encountered at the non-cage stations. The cumacean *Dimorphostylis cottoni* and the capitellid *Mediomastus australiensis* were also widely represented at these stations. It seems that the capitellid *Mediomastus australiensis* replaced *Capitella capitata* complex as the level of organic enrichment decreased, as it was frequently found as a characteristic species at the between cage stations (5 – 11% of within group similarity, 6 – 13% of similarity). Station 3 was also between cages but in this case the dominant fauna was crustacean; the phoxocephalid amphipod *Birubius cartoo* and the ostracod *Euphilomedes* sp. made up 21% of the within station similarity (Appendix 2.14). These are both benthic burrowing crustaceans, with phoxocephalids generally preferring more fully marine conditions to reduced salinity estuarine areas (Barnard and Drummond, 1978). Station 7, the reference station at the southern end of the lease, also tended to be

dominated by crustacea, with *Birubius cartoo* again comprising a large proportion of the within station similarity (21%) and another ostracod *Archasterope* sp. along with *Euphilomedes* sp. and the cumacean *Cyclaspis caprella* making up a further 39% of the station similarity (Appendix 2.14). Reference station 8, at the northern end of the lease, was characterised by *Pista australis* and *Mediomastus australiensis* (26%), whilst 25 % of the within group similarity at reference station 9 (further offshore) was due to the presence of the surface deposit feeding polychaetes *Phyllamphicteis* sp, Trichobranchidae sp.1 and the cumacean *Dimorphostylis cottoni* (Appendix 2.14). The burrowing phoxocephalid amphipod *Brolgus tattersalli* and the surface deposit feeding polychaete *Pista australis* accounted for 26% of the similarity at station 4 (between cages) and reference station 7 (Appendix 2.14).

The primary species responsible for the distinction between the cage group and the remaining stations were *Capitella capitata* complex and *Malacoceros tripartitus*. Both species were found in much greater abundances at the cage stations and contributed 11.6% of group dissimilarity (Table 2.10c). Three of the species which characterised the non-cage stations (*Pista australis, Phyllamphicteis* sp cf *foliata*, *Dimorphostylis cottoni*) also contributed to the between group dissimilarity (9.3%).

ABC plots for the spatial survey stations at Nubeena (figure 2.14) identified three categories of impact. At stations 1 and 2 both the abundance and biomass plots commence relatively high on the cumulative % dominance axis. However, for the most part, the biomass curve lies close to and only just above the abundance curve, indicating that conditions at these sites were moderately impacted. The first ranked species at station 1 comprised over 90% of the abundance and more than 80% of the biomass. Similarly, the first ranked species at station 2 accounted for over 80% of both abundance and biomass. The W-statistic for both stations is low (0.009 and 0.044 for stations 1 and 2 respectively) but neither is negative as would be expected under highly disturbed conditions.

Table 2.10 SIMPER output indicating a) and b) average abundance, ratio (average similarity/ st.dev. similarity), % similarity and cumulative % similarity of the six most important species in each of the main groups and c) average abundance, ratio (average dissimilarity/ st. dev. dissimilarity) and cumulative % dissimilarity of the six species which distinguish the main groups identified by cluster analysis. Group 1 included stations 1 and 2 and group 2 represented all the remaining stations.

	Species Name	Average Abundance	Ratio	% Similarity	Cumulative % Similarity
a.	**Group 1**				
	Capitella capitata complex	4795.06	2.31	47.65	47.65
	Malacoceros tripartitus	189.30	2.58	31.99	79.64
	Birubius cartoo	24.69	0.58	4.43	84.08
	Neanthes cricognatha	9.88	0.44	2.20	86.27
	Caprella sp.1	9.88	0.44	2.20	88.47
b.	**Group 2**				
	Pista australis	292.59	1.49	12.14	12.14
	Phyllamphicteis sp.1	115.61	0.98	7.34	19.48
	Dimorphostylis cottoni	72.77	1.02	6.24	25.72
	Mediomastus australiensis	67.97	0.85	6.07	31.78
	Birubius cartoo	45.97	0.72	5.06	36.84

	Species Name	Group 2 Av.Abund.	Group 1 Av.Abund.	Ratio	Cumul. % Dissimilarity
c.	**Between Groups**				
	Capitella capitata complex	122.44	4795.06	1.70	7.24
	Malacoceros tripartitus	0.44	189.30	3.07	11.57
	Pista australis	292.59	4.94	1.50	15.40
	Phyllamphicteis sp.1	115.61	1.65	1.37	18.30
	Dimorphostylis cottoni	72.77	0.00	1.42	20.88

2.3.5.2 Abundance-Biomass Comparisons (ABC) – Nubeena

ABC plots for the spatial survey stations at Nubeena (figure 2.14) identified three categories of impact. At stations 1 and 2 both the abundance and biomass plots commence relatively high on the cumulative % dominance axis. However, for the

most part, the biomass curve lies close to and only just above the abundance curve, indicating that conditions at these sites were moderately impacted. The first ranked species at station 1 comprised over 90% of the abundance and more than 80% of the biomass. Similarly, the first ranked species at station 2 accounted for over 80% of both abundance and biomass. The W-statistic for both stations is low (0.009 and 0.044 for stations 1 and 2 respectively) but neither is negative as would be expected under highly disturbed conditions.

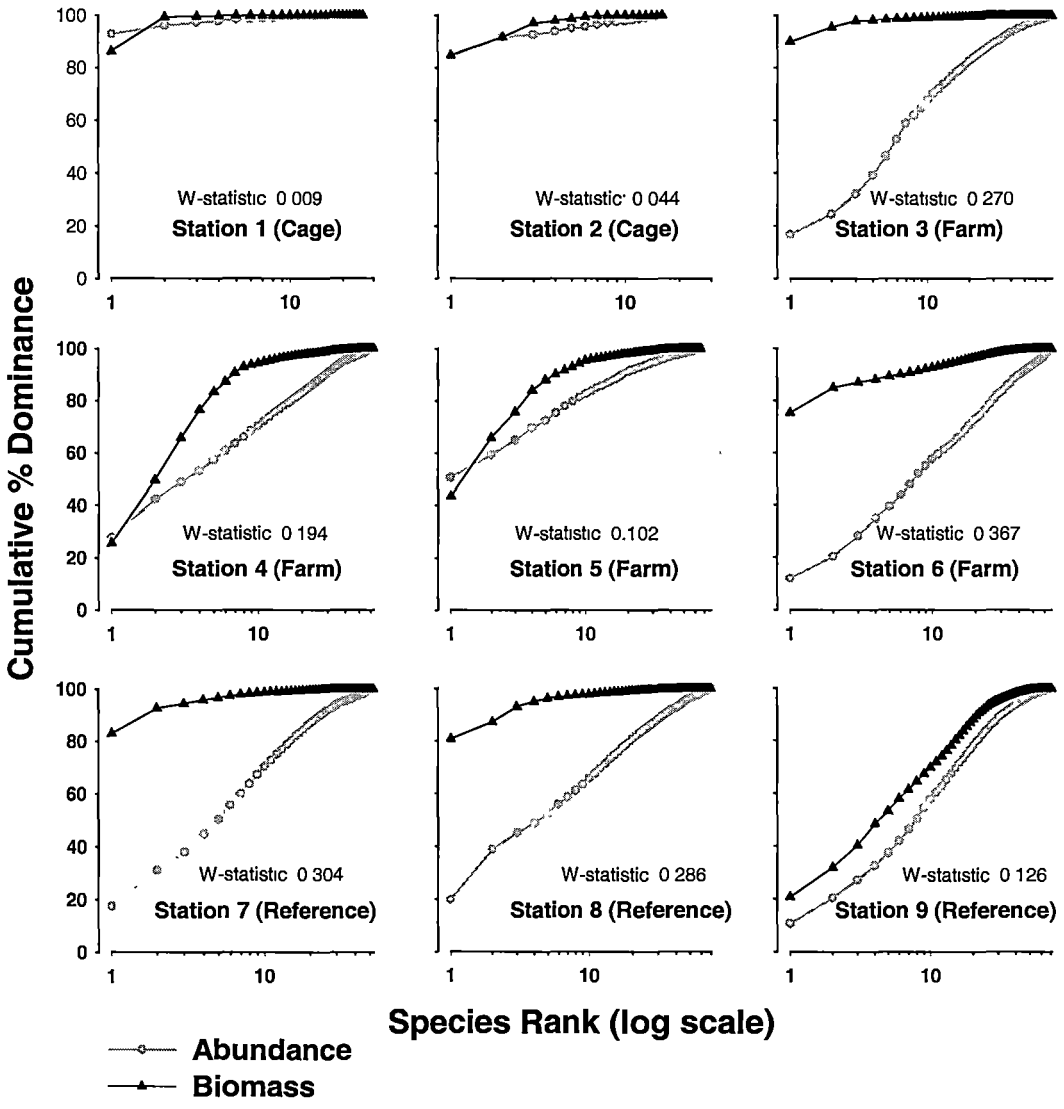


Figure 2.14 ABC plots and W-statistic values for Nubeena spatial survey stations.

At station 4, the abundance and biomass curves overlap for the first ranked species and the curve shape suggests the existence of disturbed conditions as the first ranked species contributes approximately 25% of both the total abundance and biomass.

Similarly, the plot for station 5 is indicative of moderate disturbance. The abundance and biomass curves for station 9 appear to be indicative of relatively undisturbed conditions, however, both the curves start low on the plot and rise slowly indicating an absence of the larger bodied individuals commonly found under unimpacted conditions.

The remaining plots (stations 3, 6, 7 and 8) are characteristic of unimpacted conditions. The biomass curve lies well above the abundance curve which rises gently. The W-statistics are positive and higher than in the moderately impacted or impacted plots.

ANOVA of the W-statistic results for the replicates from the stations at Nubeena (Table 2.11) indicated that there were significant differences between the stations and pairwise comparisons (Appendix 2.15) identified that these differences were between station 1 and stations 6 and 7.

Table 2.11 ANOVA of the W-statistic for Nubeena spatial survey stations.

	df	MS	F-ratio	P
Station	8	0.074	3.666	0.004
Error	34	0.020		

2.3.5.3 Univariate measures – Nubeena

The average number of species recorded from each station at Nubeena during the spatial survey are shown in figure 2.15. ANOVA (Table 2.12) and pairwise comparisons (Appendix 2.16) confirm that there were significantly fewer species recorded from station 2 relative to all other stations except stations 1 and 7. Station 1 also had significantly fewer species than stations 3 and 9, and the number of species recorded from station 7 was significantly reduced compared to station 9. The two cage associated stations had lower numbers of species than the remaining stations (13 and 5 for stations 1 and 2 respectively) and the reference stations had much higher numbers (19, 27 and 35 for stations 7, 8 and 9 respectively).

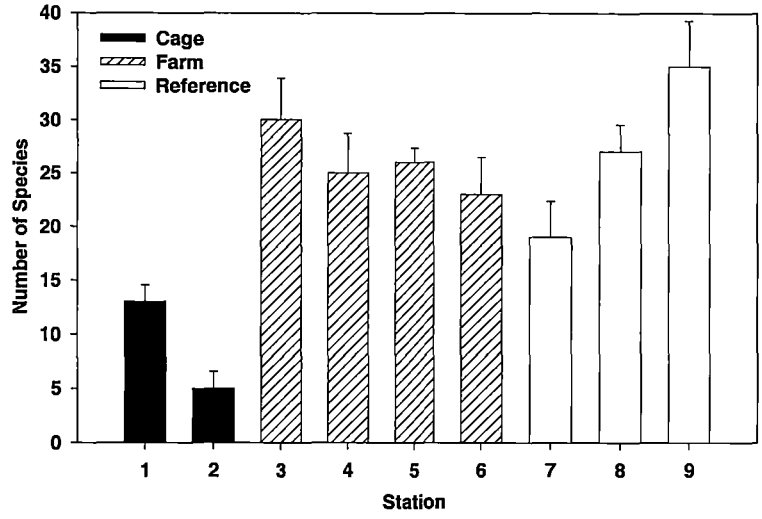


Figure 2.15 Mean number of species (+s.e.) recorded from Nubeena spatial survey stations.

Table 2.12 ANOVA of the number of species recorded from the spatial survey stations, Nubeena.

	df	MS	F-ratio	P
Station	8	389.234	8.488	<0.001
Error	34	45.859		

The mean number of individuals m^{-2} (Figure 2.16) was significantly higher at station 1 (ANOVA; Table 2.13 and pairwise comparison Appendix 2.17) relative to all other stations. An average of 10,733 individuals m^{-2} were recovered from this station.

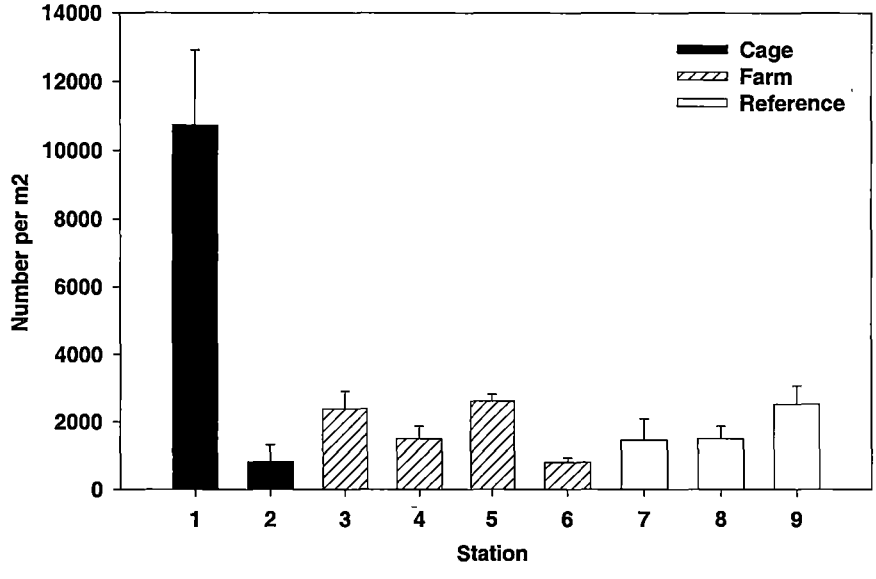


Figure 2.16 Mean number m^{-2} (+s.e.) for the Nubeena spatial survey stations.

Table 2.13 ANOVA of the number of species recorded from the spatial survey stations, Nubeena.

	df	MS	F-ratio	P
Station	8	3.929E+07	15.706	<0.001
Error	34	2501991.540		

Mean Shannon diversity index values (Figure 2.17) were significantly different between stations (ANOVA; Table 2.14) and the pairwise comparisons (Appendix 2.18) showed that these differences were associated with stations 1 and 2. Station 1 was significantly different to all stations except station 2 and station 2 was significantly different to all other stations except 5.

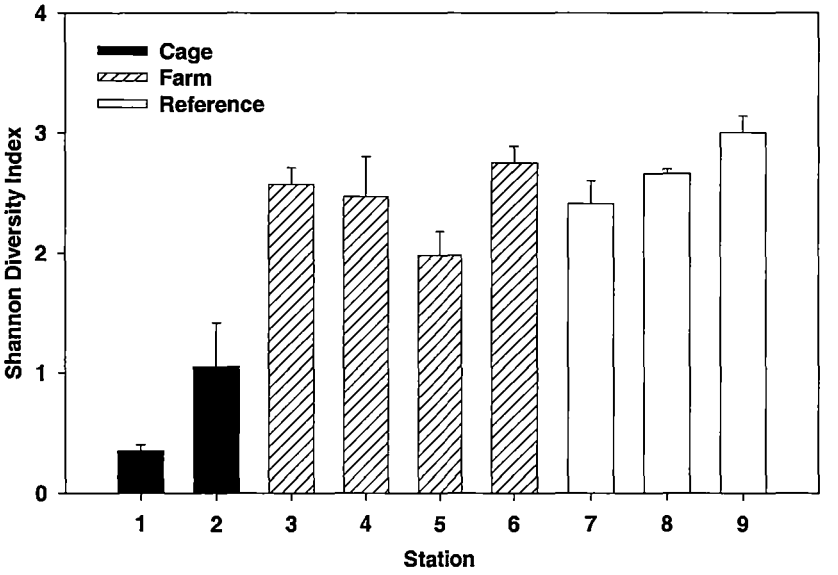


Figure 2.17 Mean Shannon diversity indices (+s.e.) for the Nubeena spatial survey stations.

Table 2.14 ANOVA of the Shannon diversity indices for the spatial survey stations, Nubeena.

	df	MS	F-ratio	P
Station	8	3.425	15.780	<0.001
Error	34	0.217		

2.3.5.4 Major faunal groups – Nubeena

The abundance of annelids at station 1 was approximately ten times that of the other sample stations (Figure 2.18). The greatest proportion of the annelids recorded from station 1 were *Capitella capitata* complex. There were significant differences between the stations in relation to abundance of each of the major faunal groups (ANOVA; Table 2.15). Pairwise comparison of the annelid data (Appendix 2.19) indicated that station 1 was significantly different to all other stations. Similar analysis of the crustacean data (Appendix 2.20) showed there were significant differences between only station 2 and stations 3 and 7, whilst station 9 differed from all stations other than stations 5 and 7 with regard to the number of molluscs observed (Appendix 2.21). In general terms, the abundance of annelids at station 1, where *Capitella capitata* complex was the primary species recorded, was 10 times that of the other stations (Figure 2.18), while, relative to the remaining stations, the crustacean abundance appeared to be increased at stations 3 and 7 and slightly reduced at station 2. A large proportion of the increases recorded from stations 3 and 7 could be attributed to increased numbers of an ostracod, *Euphilomedes* sp.

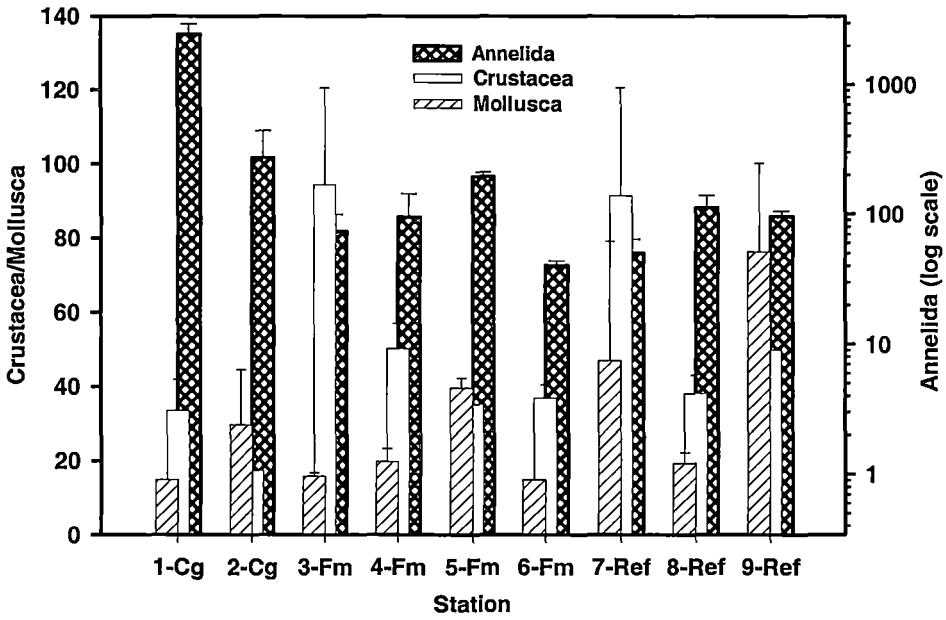


Figure 2.18 Mean number.m^{-2} (+s.e.) of Annelida (log scale), Crustacea and Mollusca sampled from the Nubeena spatial survey stations.

Finally, the high molluscan abundance associated with station 9 was mainly a result of large numbers of two bivalve molluscs, *Theora fragilis* and *Tellina margaritina.*

Table 2.15 ANOVA of the a) Annelida, b) Crustacea and c) Mollusca abundances from the spatial survey stations, Nubeena.

a) Annelida	df	MS	F-ratio	P
Station	8	2491345.240	22.259	<0.001
Error	34	111925.850		

b) Crustacea	df	MS	F-ratio	P
Station	8	3512.784	4.148	0.002
Error	34	846.921		

c) Mollusca	df	MS	F-ratio	P
Station	8	2199.693	3.444	0.005
Error	34	638.689		

2.3.5.5 Multivariate Community Assessment – Meads Creek

Multivariate assessment of the spatial survey data from Meads Creek produced a primary dichotomy which differentiated stations 2 and 4 at a between group similarity level of approximately 20% (Figure 2.19a). The first dichotomy within the remaining group occurred at a similarity level of approximately 38%, and distinguished stations 11 and 8 whereas the two stations (2 and 4) identified in the first separation appear to be less similar than any of those in the remaining group as they separated at a similarity level of approximately 24%.

Ordination (Figure 2.19b) showed that there was considerable variability in the unimpacted group of stations at Meads Creek, in fact the variability appears to be greater than that exhibited at Nubeena (Figure 2.13b). The distinction between the two sites forming the primary group in the cluster analysis (2 and 4) is also apparent.

ANOSIM of the individual stations (Appendix 2.22) indicated significant differences between most stations. However, the two stations which were separated at the primary dichotomy on the cluster analysis (2 and 4) were not significantly different. There also appeared to be no significant differences between the outer boundary stations (5, 6 and 13), the reference stations (9, 10 and 11) and the unimpacted inshore stations (7, 8 and 12). This observation is supported by the results of ANOSIM of the a priori defined groupings of cages, farm stations and reference stations (Appendix 2.23). Here the analysis indicated that the cage stations were

significantly different from both the on farm and reference stations but that the reference stations were not significantly different from the farm stations.

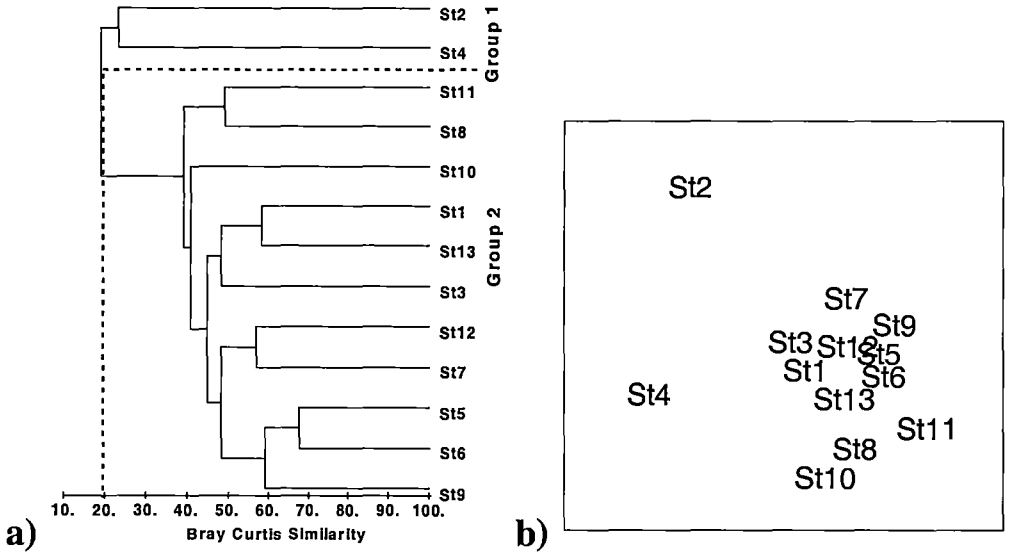


Figure 2.19 Multivariate output for species abundance data from the spatial survey at Meads Creek a) Cluster analysis -Dendrogram b) MDS ordination plot (Stress=0.12). All data √√ root transformed and replicates combined.

SIMPER analysis (Table 2.16) showed that the faunal community at station 2 was dominated by *Capitella capitata* complex which contributed 72% of the group similarity. Two other dominant species recorded at this station were *Nassarius nigellus* and the nereid polychaete *Neanthes cricognatha* which represented 16.7% and 7.6% of the group similarity respectively. Thus, together these three species made up 96.3% of the overall similarity of the replicates at station 2. Station 4 was also identified as being significantly different from the remaining stations. At this station the fauna was dominated by two other species, the spionid polychaete *Malacoceros tripartitus* (39%) and the leptostracan crustacean *Nebalia* sp. (30%). *Nebalia* sp. is a small swarming epibenthic crustacean which may often be found in areas with high organic enrichment and is often associated with decaying plant material on the seabed (Edgar, 1997). The fact that this species is mobile and epibenthic may result in it being missed when sampling and therefore it might not be considered as a consistent component of the fauna, however, removal of this species from the analysis did not change the overall pattern. Station 4 was still distinguished as a result of the high abundance of *Malacoceros tripartitus*.

At the remaining stations the fauna was not obviously dominated by any particular species, however, several species did appear to be common. These species included the bivalve mollusc *Theora fragilis,* which accounted for 15% of the overall group similarity, Nemertea spp. which accounted for 9% and the brittle star *Amphiura elandiformis* which accounted for 8%. None of these species were consistently found at all of the unimpacted stations, consequently they could not be classed as indicator species. Most of the "unimpacted" stations at Meads Creek recorded the presence of *Capitella capitata* complex but the level at which it appeared was variable, with some stations having quite high abundances (eg. station 3) whilst at others, the numbers recorded were very low. The species was only absent from station 13.

Table 2.16 SIMPER output indicating (a), b) and c)) average abundance, ratio (average similarity/ st.dev. similarity), % similarity and cumulative % similarity of the three most important species in each of the main groups and (d), e) and f)) average abundance, ratio (average dissimilarity/ st. dev. dissimilarity) and cumulative % dissimilarity of the three species which distinguish the main groups identified by cluster analysis. Group 1 represents station 2, group 2 represents station 4 and group 3 represents all the remaining stations.

	Species Name	Av. Abund.	Ratio	Percentage Similarity	Cumul. % Similarity
a.	**Group 1**				
	Capitella capitata complex	21917 04	18.42	71.99	71.99
	Nassarius nigellus	103.70	4.53	16.67	88 66
	Neanthes cricognatha	11.85	1.16	7 64	96 30
b.	**Group 2**				
	Malacoceros tripartitus	204.44	0.62	38 71	38 71
	Nebalia sp.1	4640 00	0.32	30 44	69 15
	Zoea (un-identified)	11.85	0.32	12.81	81 96
c.	**Group 3**				
	Theora fragilis	146 78	1.11	14 87	14.87
	Nemertea *sp.*	28 53	0.89	8 87	23.74
	Amphiura elandiformis	34.02	0 77	7 71	31.45

d.	Species Name	Group 2 Av.Abund.	Group 1 Av.Abund.	Ratio	Cumul. % Dissimilarity
	Between Groups (1 & 2)				
	Capitella capitata complex	62.22	21917.04	2 99	37.17
	Nebalia sp.1	4640.00	11.85	1 07	48.34
	Nassarius nigellus	2.96	103.70	2.37	56.91

e.	Species Name	Group 3 Av.Abund.	Group 1 Av.Abund.	Ratio	Cumul. % Dissimilarity
	Between Groups (1 & 3)				
	Capitella capitata complex	1893.00	21917.04	2.72	19 07
	Theora fragilis	146.78	0.00	1.53	23.79
	Nassarius nigellus	27 98	103 70	1.36	27.21

f.	Species Name	Group 3 Av.Abund.	Group 2 Av.Abund.	Ratio	Cumul. % Dissimilarity
	Between Groups (2 & 3)				
	Nebalia sp 1	7.13	4640.00	0 84	7.13
	Theora fragilis	146.78	0 00	1 41	12 47
	Capitella capitata complex	1893.00	62.22	0.77	17.34

2.3.5.6 ABC Comparisons – Meads Creek

The ABC curves for the spatial survey stations at Meads Creek (Figure 2.20) provide a picture of the station conditions which is similar to that generated by the multivariate analyses. The plots for stations 2 and 4 indicate highly disturbed conditions, with both the abundance and biomass plots starting high on the % dominance axis and the abundance curve lying above the biomass curve. Furthermore, the W-statistic was negative in both cases. The ABC plots also indicate that station 3 was highly disturbed. This station, like station 4, was between two cages (Figure 2.3, Table 2.2), and once again both the abundance and biomass plots commence relatively high on the % dominance axis. The abundance curve lies above the biomass curve and the associated W-statistic is negative.

The plots for the remaining stations indicate relatively undisturbed conditions except for station 12 which appeared to be moderately disturbed (Figure 2.20). This station was located inshore towards the middle of the lease (Figure 2.3, Table 2.2). The curves for station 12 cross each other and the biomass curve starts relatively low on the % dominance axis whilst the abundance curve is higher. In addition the W-statistic for station 12 was low, although not negative. The first ranked species in this case accounted for approximately 55% of the overall abundance.

All other stations displayed curves representative of undisturbed conditions with the abundance plot rising gently from a start point low on the % dominance axis and the biomass curve lying above the abundance curve. For all these remaining stations the W-statistic was positive.

ANOVA of the W-statistic for the replicates from the stations in the spatial survey (Table 2.17) indicated significant differences between the stations. Further analysis of these differences (pairwise comparisons, Appendix 2.24) showed that stations 2 and 3 were significantly different from all stations other than stations 4 and 12 and that station 4 was significantly different from station 10.

Table 2.17 ANOVA of the W-statistic for all stations in the spatial survey, Meads Creek.

	df	MS	F-ratio	P
Station	12	0.212	9.300	<0.001
Error	50	0.023		

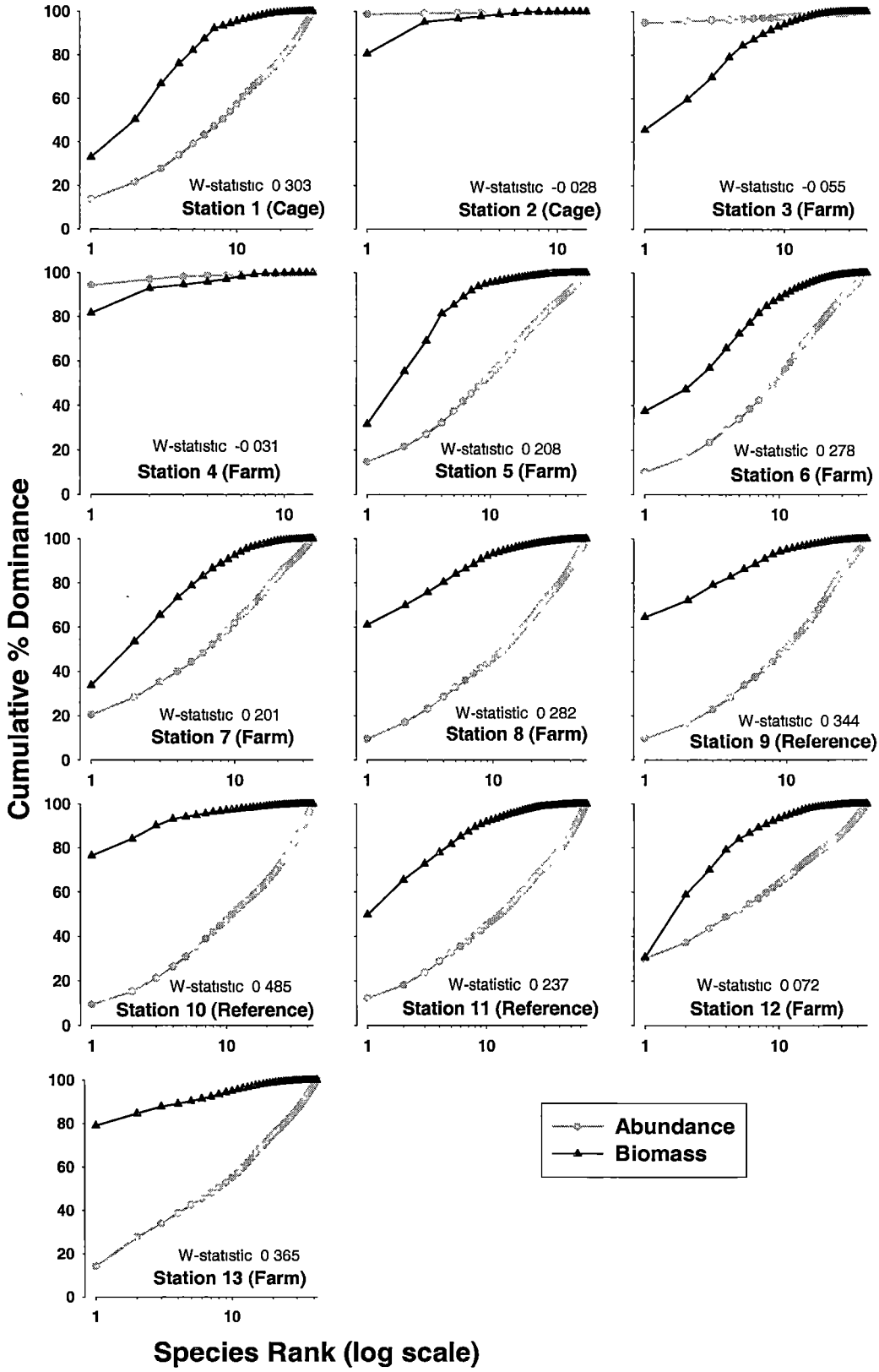


Figure 2.20 ABC plots and W-statistics for Meads Creek spatial survey stations.

2.3.5.7 Univariate measures – Meads Creek

ANOVA of the mean species number (Table 2.18) indicated significant differences between the stations and pairwise comparisons (Appendix 2.25) showed that stations 2 and 4 were significantly different to all other stations with the exception of station 1 (Figure 2.21) while the number of species at station 5 was significantly higher than that recorded at stations 1, 2, 3, 4, 7, 10 and 12. Station 11 also displayed a significantly higher number of species than these stations with the exception of station 3.

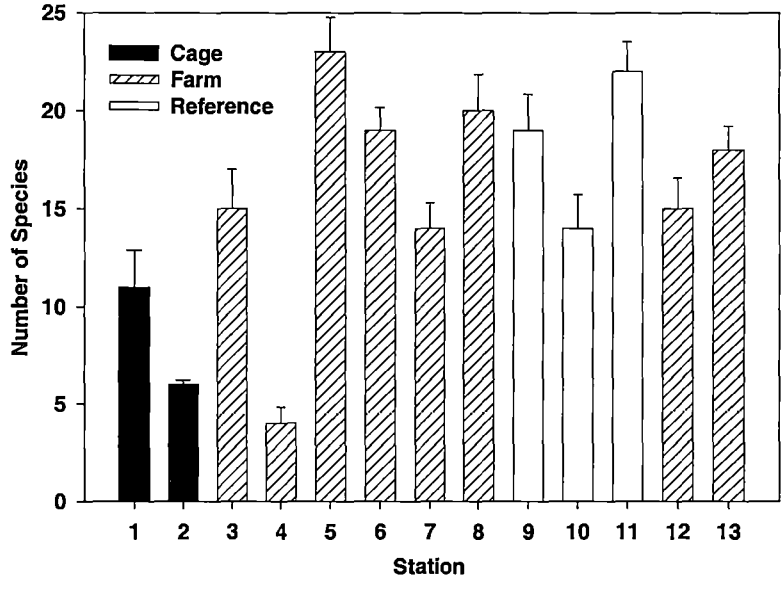


Figure 2.21 Mean number of species (+s.e.) from the Meads Creek spatial survey stations.

Table 2.18 ANOVA of the number of species from spatial survey stations, Meads Creek.

	df	MS	F-ratio	P
Station	12	163.397	14.164	<0.001
Error	51	11.536		

ANOVA of abundance data (Table 2.19) identified that there were significant differences between stations, and the pairwise comparisons (Appendix 2.26) showed that stations 2 and 3 had significantly higher abundances than all other stations (Figure 2.22). The number of individuals recorded from station 4 also appeared to be

slightly higher than that from the remaining stations (Figure 2.22). However, the difference was not significant (Appendix 2.26).

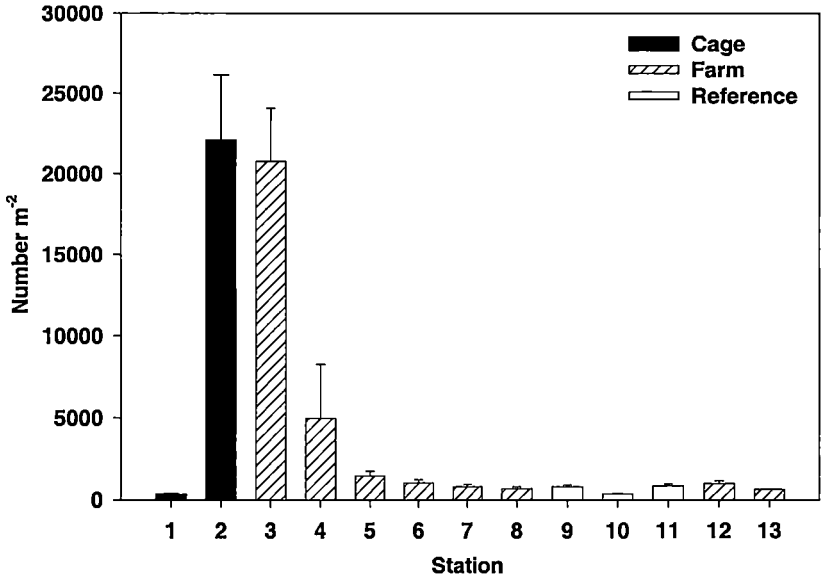


Figure 2.22 Mean number m^{-2} (+s.e.) recorded from each station in the Meads Creek spatial survey.

Table 2.19 ANOVA of the mean number m^{-2} recorded from all stations in the spatial survey, Meads Creek.

	df	MS	F-ratio	P
Station	12	2.953E+08	19.541	<0.001
Error	51	1.511E+07		

There were also significant differences in the Shannon diversity index between the stations (ANOVA, Table 2.20) and pairwise comparisons (Appendix 2.27) showed that there were highly significant differences in the index values between stations 2, 3 and 4 where the values were all less than 1 and all other stations (Figure 2.23), while these three stations were not significantly different from one another. Station 12 was also found to be significantly different from all stations, other than stations 1 and 7.

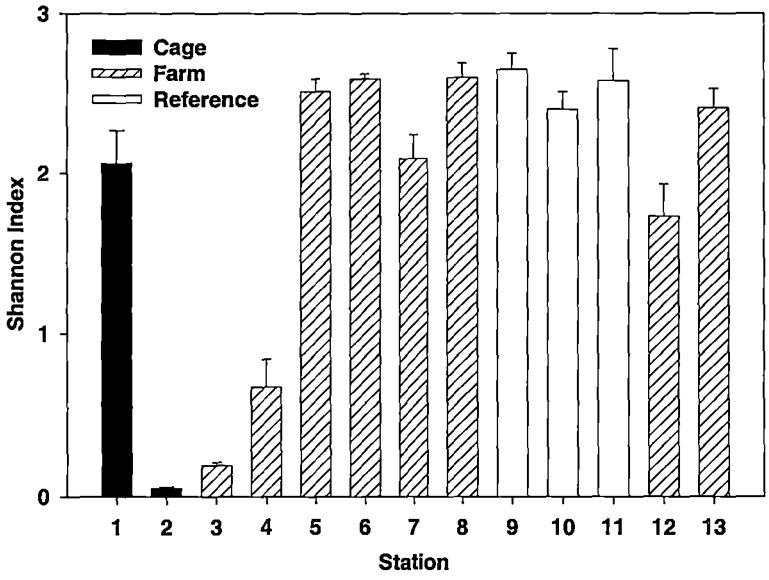


Figure 2.23 Shannon diversity index values (+s.e.) calculated for Meads Creek spatial survey stations.

Table 2.20 ANOVA of the Shannon diversity index values for the spatial survey stations, Meads Creek.

	Df	MS	F-ratio	P
Station	12	4.454	50.909	<0.001
Error	51	0.087		

2.3.5.8 Major faunal groups – Meads Creek

Figure 2.24 shows the mean abundances of each of the major faunal groups (annelids, crustaceans and molluscs) from the spatial survey at Meads Creek and indicates that annelid abundance was significantly increased (ANOVA, Table 2.21a) at station 2 (pairwise comparison, Appendix 2.28). Abundances were also elevated at stations 3 and 4 but not significantly so. Assessment of the faunal composition showed that the increases in abundance at stations 2, 3 and 4 were almost entirely as a result of the polychaete *Capitella capitata* complex.

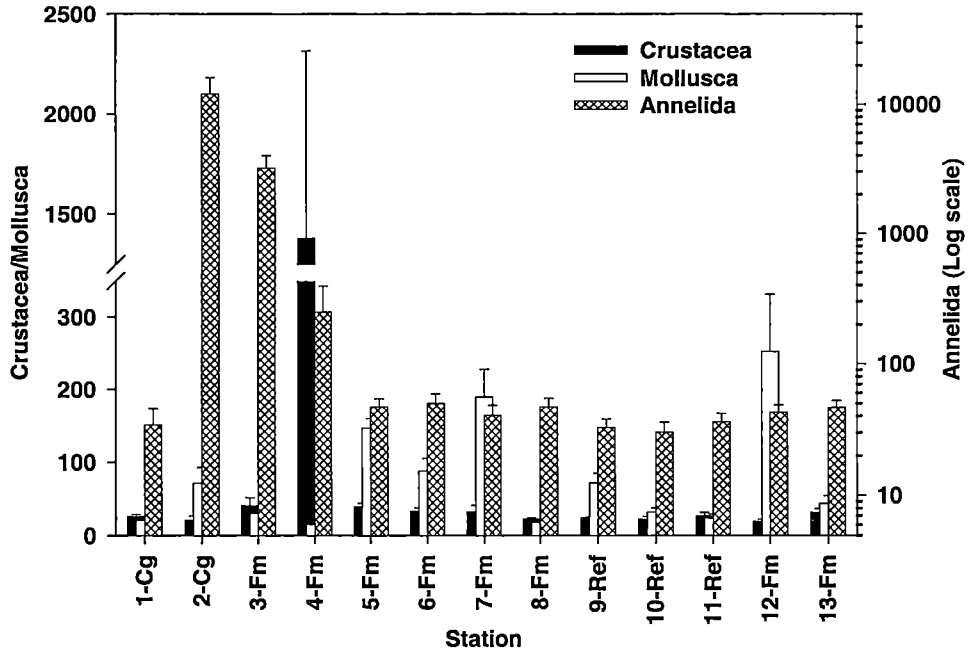


Figure 2.24 Numbers m^{-2} of Annelida, Crustacea and Mollusca sampled from the Meads Creek spatial survey stations.

In contrast Crustacea numbers (Figure 2.24) were significantly elevated at station 4 compared with all the other stations (ANOVA, Table 2.21b and pairwise comparisons, Appendix 2.29). In this case the increased numbers were largely as a result of a swarm of *Nebalia* sp.

Table 2.21 ANOVA of the a) Annelida, b) Crustacea and c) Mollusca abundances from the spatial survey stations, Meads Creek.

a) Annelida	Df	MS	F-ratio	P
Station	12	5.5621E+07	8.013	<0.001
Error	50	6941700.797		

b) Crustacea	df	MS	F-ratio	P
Station	12	569663.900	2.710	0.007
Error	50	210215.282		

c) Mollusca	df	MS	F-ratio	P
Station	12	26076.290	6.533	<0.001
Error	45	3991.392		

ANOVA of molluscan data (Table 2.21c) indicated that there were significant differences between the stations and subsequent pairwise comparisons (Appendix 2.30) identified two stations as being different from many of the others. Station 12 was significantly different from all stations except 5 and 7 and station 7 was significantly different from stations 1, 3, 4, 8, 10, 11 and 13. Faunal analysis showed that at stations 12 and 7 the differences were largely due to increased numbers of the introduced bivalve mollusc *Theora fragilis*. This species was also found in relatively high numbers at station 5, although not in sufficient abundance as to be significantly different to the remaining stations.

2.3.6 Comparison of Physical / Chemical Parameters and Benthic Macrofauna

2.3.6.1 Nubeena

Analysis of the results for the physical / chemical parameters measured in the spatial survey at Nubeena showed that there was little or no correlation between % silt-clay and % organic matter content at Nubeena (r^2=0.068). However, as would be expected, there was a strong correlation between the various measures of redox potential (i.e. surface redox potential and RPD depth) resulting in an r^2 value of 0.862. Results of the BIOENV analysis for Nubeena indicated that the best correlation between the benthic community structure and environmental parameters was achieved with the RPD depth (r=0.665).

The physical-chemical factor data set was adjusted where strong correlations between factors existed and the results of the multivariate analysis of these factors for all stations are shown in figure 2.25. The dendrogram (Figure 2.25a) shows that station 2 can be distinguished from all the others at the first dichotomy and that the second dichotomy then separates station 1. The ordination plot (Figure 2.25b) shows that all of the remaining stations formed a very compact group (Bray-Curtis similarity greater than 90%).

RELATE analysis of the biotic and physical-chemical factor matrices, indicated that there was a significant relationship between the matrix produced using the environmental variables % silt-clay, % organic matter and RPD depth and the matrix resulting from the faunal abundance data (Sample statistic = 0.787, p = 0.007).

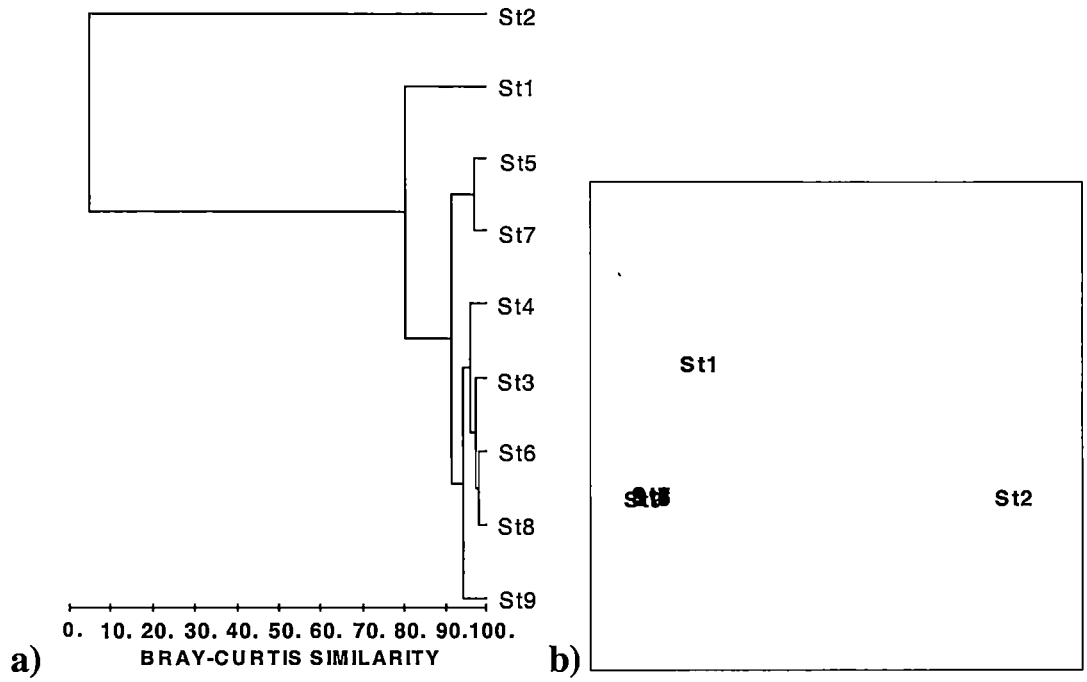


Figure 2.25 Multivariate output for the results of the measured physical / chemical factors; % silt-clay, % organic matter and RPD depth, for the spatial survey at Nubeena. a) Cluster analysis -Dendrogram b) 2 dimensional MDS ordination plot (Stress=0.01). Bray-Curtis similarity measure is used as the rank correlation coefficient.

2.3.6.2 Meads Creek

Analysis of the physical / chemical factors at Meads Creek revealed a much stronger correlation between the % silt-clay and % organic than was observed at Nubeena, (r^2=0.646). Once again the measures of redox potential were found to be strongly correlated; regression of surface redox potential against RPD depth resulted in r^2=0.822. The BIOENV analysis for Meads Creek indicated that the best correlation between the benthic community structure and the environmental factors measured was relatively poor (r=0.425) and involved a combination of grain size measures, measurement of % organic matter and redox. No single parameter appeared to be able to clearly reflect the benthic patterns.

At the Meads Creek site the results of the multivariate analysis of the physical-chemical factors for all stations (Figure 2.26) separated stations 1 and 12 from all other stations at the first dichotomy with the remaining stations forming a much less tightly clustered group than was observed at Nubeena. The second group could be

further divided into two sub-groups. The first of these sub-groups contained stations 2, 3, 5 and 13 whilst the second group comprised stations 4, 6,7, 8, 9 10 and 11. The ordination plot (Figure 2.26b) shows the spatial separation of the 3 main groupings identified in cluster analysis. Stations 1 and 12 are quite distinct from the rest of the stations, whilst the sub-groups suggested by the second dichotomy were less well defined and tended to merge into a single broad group.

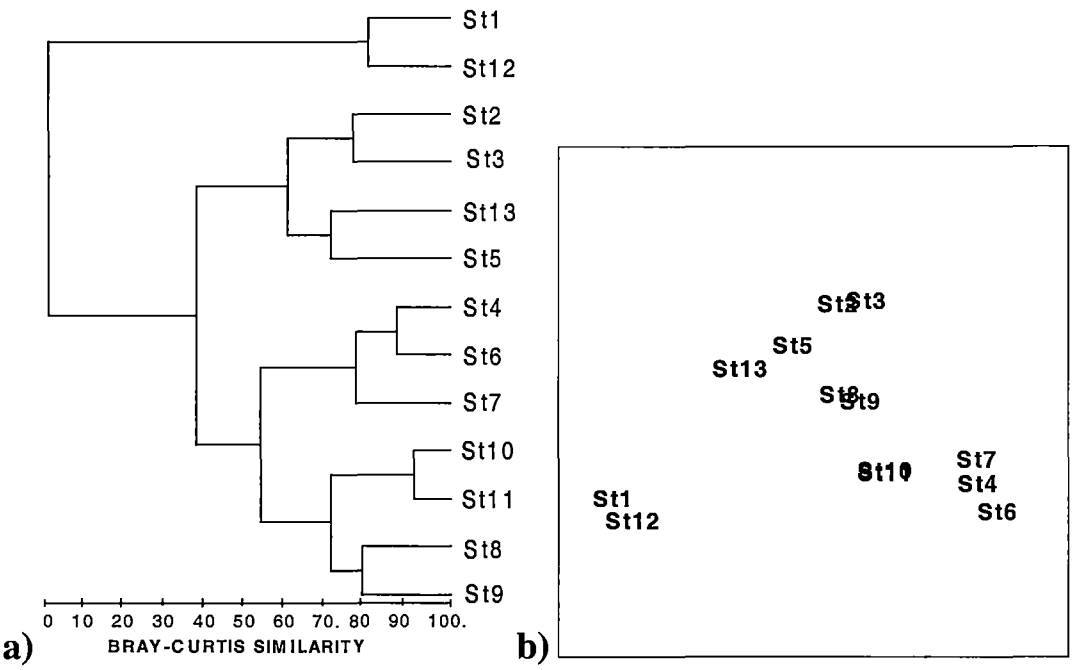


Figure 2.26 Multivariate output for the results of the measured physical / chemical factors: % silt-clay, % organic matter and RPD depth, for the spatial survey at Meads Creek. a) Cluster analysis -Dendrogram b) 2 dimensional MDS ordination plot (Stress=0.02). Bray-Curtis similarity measure is used as the rank correlation coefficient

RELATE analysis indicated that there was no significant relationship between the matrix produced using the environmental variables % silt-clay, % organic matter and RPD depth and the matrix resulting from the faunal abundance data (Sample statistic= -0.197, p= 89.1%).

2.4 Discussion

The results for sediment composition, salinity, depth and current flows clearly showed that the two study sites differed with regard to their environmental influences

and confirmed the basis upon which they were selected, as each of these factors can be expected to influence the natural faunal composition at each site.

There have been many studies which have shown a relationship between sediment particle size and current flow (eg. Rosenthal et al., 1988). The sediment at Nubeena was generally coarser than that at Meads Creek, suggesting stronger current flows, but this was not supported by current measurements. However, it should be noted that these measurements were taken over only a relatively short period of time (2-4 weeks), near the water surface (< 5m depth) and at only one or two positions within each lease. Thus, it is likely that the sediment composition at Nubeena more accurately reflects the true water flow dynamics of the area where severe tidal effects have been observed and where multiple storm events have resulted in the loss of equipment. In fact, on one occasion during the sampling period, a storm affected the site to the extent that cage nets, which normally float 3-5m above the bottom, were dragged along the sediment surface. The finer sediments at Meads Creek could be further separated into two groups, for which depth appeared to be the determining factor; the finest sediments being associated with the deeper stations.

2.4.1 Full Species-Level Faunal Assessment

Full species level faunal assessment of the community structure provided the benchmark against which each of the proposed farm assessment techniques were evaluated. At Nubeena the full benthic assessment (using both multivariate techniques and the ABC method) clearly distinguished the two cage stations 1 and 2 as impacted. The fauna at these stations was dominated by two species, *Capitella capitata* complex and *Malacoceros tripartitus,* but most particularly by the former. This species (previously recorded in Australia as simply *Capitella capitata*) is thought to be ubiquitous and has long been associated with areas of high organic enrichment (Pearson and Rosenberg, 1978; Gowen et al., 1991). It is a burrowing deposit feeder and is now considered to be a species complex comprising many very closely related species. However, its ecological significance remains i.e. it is an opportunist, indicative of areas of high organic enrichment. This species was described in Pearson and Rosenberg's (1978) classic review as indicative of the "polluted" zone, an area which has partially recovered or is some distance from the "dead"/azoic zone and is defined by an impoverished fauna. Spionid polychaetes,

such as *Malacoceros tripartitus,* are also often associated with areas of high organic enrichment. This species is typically a deposit feeder which collects particles by spreading its long palps over the sediment surface, but in some cases it also uses the palps to filter feed (Hutchings, 1984). In contrast, the unimpacted stations at Nubeena showed a more diverse fauna in which there were no particular dominants, and overall, these stations exhibited a faunal composition typical of the local marine fauna (Edgar, 1997).

The full faunal community evaluation at Meads Creek also highlighted two stations (2 and 4) as being severely impacted. Station 2 again displayed the characteristic impacted faunal composition, and was dominated by *Capitella capitata* complex. The fauna at station 4 was also indicative of organic enrichment but was less clearly dominated by *Capitella capitata* complex, suggesting that the overall impact at this station may have been slightly less than at station 2. As this station was between, rather than under, cages a lesser impact could be expected. As observed at Nubeena, the remaining stations at Meads Creek also showed a more diverse faunal community structure, indicative of the normal local estuarine conditions (Edgar, 1997; Edgar et al., 1999). Nonetheless, several of the unimpacted stations at Meads Creek recorded quite high numbers of *Capitella capitata* complex. This suggests that it was not just a high abundance of *Capitella capitata* complex which distinguished station 2 as impacted, but rather the high abundance of this species in combination with the absence of other species. The presence of *Capitella capitata* complex at low levels in many of the background samples supports the suggestion by Rosenberg (1976) and Woodward et al. (1992) that estuarine ecosystems have a greater natural predisposition to organic enrichment than fully marine environments. This theory is further supported by the results of a recently completed study (CSIRO Huon Estuary Study Team, 2000) which indicated very high background levels of organic material in the estuary.

2.4.2 Faunal Assessment – Simpler Approaches

Numerous studies have examined the effects of pollution or disturbance events on species diversity. Many have dealt with organic pollution (Pearson and Rosenberg, 1978; Grizzle, 1984; Essink and Beukema, 1986; Austen et al., 1989; Moore and Rodger, 1991; Ferraro et al., 1991) and several have looked specifically at the effects

of fin-fish farming (eg. Brown et al., 1987; Ritz et al., 1989; Weston, 1990; Lim, 1991; Camargo, 1992; Wu et al., 1994; Drake and Arios, 1997; Lu and Wu, 1998). All of these studies provide evidence showing that, overall, species diversity decreases with increasing organic load, although an initial phase of biostimulation may occur at low levels of enrichment (Holmer, 1991). In the current study, although the number of species was reduced at each of the stations which had been determined to be impacted by the full assessment, these reductions were not always statistically significant. A further problem associated with species enumeration is that the fauna still requires to be sorted and identified to species level, and therefore needs the same level of expertise as the full community assessment. Consequently, evaluation of the total number of species is not recommended as a farm-based technique for monitoring.

At both sites in the current study the total abundance levels clearly identified stations which appeared to have been subject to a significant impact. However, these stations were not the same as those identified by the full community assessment. For example, station 2 at Nubeena was not identified by this approach and station 4 at Meads Creek displayed only a slightly increased abundance. In the main, the increased abundance levels were due to increases in the numbers of annelids (polychaetes) at these stations, and specifically to increases in *Capitella capitata* complex. Although not all of the stations were identified by this method at levels which were significant, this technique did distinguish the most impacted stations and graphical presentation tends to reflect impact trends in others. Total abundance is often applied as a measure of impact in environmental monitoring and generally total abundance levels are low in heavily polluted areas. As the impact subsides or with distance from the pollutant source abundance then rises dramatically as a result of extremely abundant populations of one or two opportunistic species. Further reduction of impact or distance results in a rapid decline in abundance until the normal stable community structure is achieved (Pearson and Rosenberg, 1978). Evaluation of total abundance is relatively easy to undertake, requires no skills in identification and can provide a quick indication of impact, particularly in relation to those stations where impact is severe. Consequently, this method can be considered a useful approach for farm-based assessment.

At Nubeena the two cage associated stations 1 and 2 were readily distinguished using the Shannon index and the distinction was statistically significant. Similarly, at Meads Creek stations 2, 3 and 4 were distinguished as significantly different on the basis of Shannon index. The Shannon diversity index is one of the most commonly applied diversity measures in ecological assessments. A decline in the Shannon index is frequently associated with a deterioration in the faunal community structure, such as that resulting from organic enrichment (Pearson and Rosenberg, 1978). However, diversity measures such as this can be strongly influenced by both sampling method and by habitat, therefore it is strongly recommended that comparisons of this index are confined "within habitat" (Pearson and Rosenberg, 1978). Importantly, while calculation of the Shannon index appears to provide a good evaluation of sediment condition, this method still requires identification and enumeration of the fauna to species level.

A further simplification of the full faunal assessment would be to evaluate only key sub-groups within the benthic community. There is evidence that particular faunal groups can, in some instances, be more clearly indicative of impact than others (Pearson and Rosenberg, 1978; Mattson and Linden, 1983; Kaspar et al, 1985). The species assessment data for the current study suggests that the community structure has been strongly affected by variations in the abundance of the Annelida. Therefore, evaluation of this group alone may be sufficient to detect change, and indeed station 1 at Nubeena could easily be identified by assessment of annelid abundance. At Meads Creek, where increases in the abundances at the impacted stations were much greater, stations 2, 3 and 4 were all clearly identifiable using annelid abundance. This suggests that the annelids alone may be as reliable as evaluation of the total fauna.

Evaluation of the crustacean community structure reflected by the current data set generally did not identify impacted stations at either Nubeena or Meads Creek, with the exception of station 4 at Meads Creek. This station could be distinguished as a result of the high abundance of *Nebalia* sp. The Crustacea have been shown to respond to impact in a number of ways and, often, members of this group are mobile opportunists which can rapidly move in to exploit a new food resource (eg. *Nebalia* sp.) (Grizzle, 1984). Alternatively their mobility may actually allow them to escape from a pollution event. However, as none of the other impacted stations were identified using the Crustacea and the particular species which distinguished station 4

was so mobile, it is suggested that the evaluation of crustacean abundance is not sufficiently reliable to recommend its adoption for farm based use.

Although the data from the current study at Nubeena did suggest that molluscs were, for the most part, more abundant at the reference stations than at the impacted stations, the pattern was not a reliable indicator of farm impact. The increased abundance of molluscs recorded at station 12 (Meads Creek), was due to the increased abundance of an invasive species which could not, in turn, be directly attributed to organic enrichment from the farm. Therefore, it also appears that evaluation of molluscs was not sufficiently reliable to permit recommendation as a farm assessment technique.

In summary, evaluation of the abundance of the major faunal groups appears to be of value only in respect of the annelids since annelid abundance was as useful as evaluation of the abundance of the entire community. The two other faunal groups considered showed evidence of changes in faunal structure which could not be directly attributed to the farms.

2.4.3 Sedimentation Rate

The results from the sedimentation trials suggest that the use of sediment traps as ongoing monitoring tools for assessing organic input would be inappropriate as there would be too great a risk of corruption of the data and the results could not be considered reliable.

2.4.4 Organic Matter

Organic matter levels at Nubeena were generally low which is consistent with the relatively exposed nature of the site and suggests that the organic material from the cages was being dispersed effectively. In contrast the levels of organic matter at Meads Creek were much higher, varying between 1 and 17% with reference stations also showing a high degree of variability. The organic matter levels from the two cage stations at each site were also highly variable. At Nubeena, station 1 did not differ significantly from the reference stations (1.5%) whereas the organic matter content at station 2 was the highest recorded from this site (3.4%). As both of these cages had been stocked with fish for 3 months prior to sampling it is unclear why there should be such differences in the organic matter levels. The differences

between the two stations were also reflected in the redox measurements, species numbers and total abundance. All of these factors suggest that station 1 was less impacted relative to station 2. In this context it is possible that the greater numbers of *Capitella capitata* complex recorded from station 1 may have resulted in more effective processing of the organic material and bioturbation of the sediment, which in turn resulted in reductions in the overall organic matter levels and increased sediment oxygenation. The multivariate assessment and the ABC analysis showed only slight differences between the faunal composition at the two stations, and in both cases the analyses indicated that the stations were highly impacted. Thus, it might be speculated that the improvement observed at station 2 may be as a result of a reduction in the input of organic material (i.e. feed). If this was the case then the reduction must have been a recent occurrence as the faunal composition would appear not to have altered to reflect such a change in input. Temporal evaluation of changes in the organic matter levels in relation to benthic infaunal changes and changing farm management practices may give a better understanding of these results.

The two cage sites at Meads Creek also had very different organic matter levels in that station 1 recorded a considerably higher level than station 2. Initially these results appear inconsistent with the cage histories as the cage associated with station 1 had been stocked for only one week whereas station 2 was associated with a cage which had been operational for 3 months. However, with the knowledge that the fauna will adapt to utilise a new source of organic material (Pearson and Rosenberg, 1978), the response can be readily explained. At first the fauna's capacity to assimilate organic material will be overwhelmed by the large increase in organic material, resulting in a net accumulation. However, as the community composition changes to one better adapted to cope with high levels of organic material, the excess will be assimilated to a greater extent, and the net impacts will be reduced. Consequently, the organic matter levels and redox potential measures at station 2 appear less affected by the cage deposition than at station 1. The faunal composition at station 2 supports this hypothesis as it is clearly impacted whilst that at station 1 is not. Thus, the fauna at station 2 appear to have adapted whereas that at station 1 has had insufficient time to respond to the impact.

The levels of organic matter recorded at Nubeena were low relative to those reported from overseas. For example, Brown et al. (1987) found organic matter levels around 9.5% associated with cage systems. In contrast, the organic matter levels from Meads Creek were on average five times higher than those encountered at Nubeena. This again, suggests that the background levels of organic matter in the Huon area are extremely high. Such high background levels of organic matter make it difficult to distinguish stations which are impacted as a result of the aquaculture practices and hinder identification of a general baseline acceptable level of organic matter. Several studies have found determination of organic matter to correlate poorly with farm impact (eg. Johannessen et al., 1994; Hargrave et al., 1997; CSIRO Huon Study Team, 2000). In some of these cases it has been suggested that the extent of biological availability is important and that measurement of the total amount of organic matter may be misleading, as the bulk of the material is not readily assimilated. However, methods for evaluation of biologically available organic matter are still developmental and are complex (Volkman (Huon Study Team) pers. comm.), making them unlikely to be appropriate for farm-based application.

Evaluation of organic matter as a farm based assessment technique therefore appears to have some fundamental limitations. While collection of samples was relatively easy (using either divers or a Craib corer), subsequent sample analysis did, however, require access to specialised laboratory equipment. Moreover, although the sample processing is neither expensive nor technically difficult, it takes 1-2 days to obtain results. Interpretation of the impact associated with particular organic matter levels is problematic and the values obtained can be misleading and are strongly influenced by background levels. The results must be interpreted in the context of other farm information and the biotic status, or viewed as a time series to avoid making errors. Interpreting isolated values could result in prematurely determining the sediment conditions to be recovered, as may have been the case at station 1 at Nubeena, or in determining the conditions to be more degraded than they are in reality, as was observed at Meads Creek station 1.

The spatial variability of the organic matter measurements resulted in further problems with data interpretation. The range of values encountered at the two study sites was extremely broad indicating that it would be impossible to set globally

applicable baseline or threshold values. Therefore it is suggested that measurement of organic matter in isolation would not provide a useful farm-based monitoring tool.

2.4.5 Redox Potential Measurement

All of the approaches to redox measurement yielded similar results. Using these methods the two cage stations at Nubeena were clearly distinguished as impacted. Both stations showed negative redox potential levels at the sediment surface and RPD depths at or near the surface. Measurement of both surface redox potential and RPD depth also showed Meads Creek, stations 1 and 4, to be impacted. Thus the redox evaluation corresponded well with the faunal assessment. However, station 2, a cage station had been stocked for longer than station 1 (3 months cf 1 week), but did not show redox values which indicated impact. Here once again, it is possible that the fauna at this station had adapted to the increased organic matter levels and was therefore better able to assimilate the organic material, which in turn resulted in improvement of redox conditions. In this context, the fauna at station 2 was clearly impacted and was dominated by *Capitella capitata* complex in extremely high abundance. In contrast the fauna associated with station 1 appeared not to have had sufficient time to adjust to the increased organic matter levels resulting in a deterioration of redox levels. A similar situation is likely to have occurred at station 4 (located between two cages) but this cannot be confirmed as the farm history relating to these cages was unavailable.

The redox profiles for both Nubeena and Meads Creek showed that at all but the impacted stations positive redox potentials were recorded to a depth of approximately 50 mm. These results compare favourably with those indicated by Gowen et al. (1991) who reported that redox potential in relatively unimpacted areas, 25 m from cages, approached zero at approximately 35 mm depth.

Pearson and Stanley (1979) observed that at Eh levels less than –150 mV the fauna was dominated by *Capitella capitata* complex. The low redox levels recorded in the current study were clearly reflected in *Capitella capitata* complex dominance. Hargrave et al. (1993) also noted that negative redox levels were associated with reduced diversity but increased *Capitella capitata* complex abundance under the cages. Wildish et al. (1999) related specific redox categories to the macrofaunal community categories proposed by Pearson and Rosenberg (1978). Redox levels

between 0 to 100 mV defined transitory communities, redox levels between 0 and –100 mV indicated polluted conditions and levels less than –100 mV typified a grossly polluted community. Based on the redox potential results obtained in the current study, station 2 at Nubeena and stations 1 and 4 at Meads Creek clearly fall into the grossly polluted category. However, the faunal composition suggests that the conditions were not this degraded and that these stations would be in the polluted category, according to Pearson and Rosenberg's criteria (Pearson and Rosenberg, 1978). At Meads Creek redox measurement clearly identified both station 1 (newly impacted) and station 4 (between cages) as grossly polluted. In general, the fauna at this site seemed to be better able to adapt and assimilate the increased organic loading than that at Nubeena. This once again supports the suggestion by Rosenberg (1976) and Woodward et al. (1992) that coastal areas such as Nubeena might be less able to adapt to increases in organic enrichment than the more estuarine environment at Meads Creek.

Each of the approaches for measurement of redox potential resulted in similar outcomes. However, from a practical perspective measurement of the full redox profile was laborious. Surface redox potential measurement was probably the easiest approach but the results obtained using this method were the most variable and it was relatively easy to inadvertently sample surface anoxic areas resulting from naturally occurring patches of decaying material. Consequently, measurement of the RPD depth appears to be the technique which would be most appropriate for farm-based application. This method was relatively simple, robust to variations in operator technique and the impacted stations could be very clearly distinguished. The correlation of the physical / chemical parameters to the biotic matrix showed that RPD depth was the best single physical-chemical measure at Nubeena.

The overall results obtained with redox measurement were encouraging, but the data suggest that redox measurement, like organic matter, can be misleading if independent values are considered. Therefore it is important to view the results in conjunction with other farm information such as cage stocking details or as a time series of data. Redox measurement appears to have a further advantage over organic matter measurement in that it may be possible to apply threshold limits, which are applicable at different sites i.e. an RPD depth less than 50 mm suggests a moderate effect, whilst RPD depth at the surface indicates a clear impact.

2.4.6 Benthos versus Physical / Chemical Factors

The overall comparison of the results of the physical / chemical parameters highlighted the differences between the two sites. At Nubeena there was little or no correlation between the particle size composition, as indicated by % silt-clay, and the organic matter content whilst at Meads Creek these two parameters were highly correlated. Levels of organic matter have been shown in some studies to be directly correlated with particle size (Rosenthal et al., 1988). On the whole, the sediment particle size was much finer at Meads Creek and the levels of organic matter were much higher, even at those sites not associated with cages. Generally, the areas in which increased organic material is likely to be deposited will be the areas with low current flow and which have finer particle sizes. (Gowen et al., 1988; Braaten, 1991). The higher correlation between particle size and organic matter at Meads Creek is therefore not surprising and conversely the low correlation at Nubeena suggests that the greater water movement at this site is responsible for dispersing the organic material.

Redox measurement appeared a useful indicator of sediment condition at both sites. At Nubeena this measure produced the best correlation with the biotic community structure. Whereas at Meads Creek the use of redox and organic matter measures, in combination, more accurately reflected the biotic structure, suggesting that the finer sediment structure at Meads Creek had a greater influence on the faunal composition.

The results also suggest that the response to increased enrichment associated with cage farming was quite different at the two sites. At Nubeena the faunal change was very dramatic with the cage enriched fauna being totally different to the normal background community. Therefore the changes in the sediment were very easily distinguishable using both the faunal and physical-chemical measures. At Meads Creek the sediments were finer and the levels of organic matter in the background environment were higher. Consequently the redox measures were more variable. This suggests that the natural system is already partially predisposed to organic enrichment and thus changes as a result of the added impact of fish-farming are less pronounced and their detection more difficult. This suggests that it may not be possible to recommend or develop a single technique which will be equally

applicable to all environmental conditions and, as suggested by Rosenthal (1994), the key variables to monitor may vary at different farms.

2.4.7 Conclusions

Assessment of univariate faunal characteristics such as number of species or the Shannon diversity index did not appear to be particularly useful in identifying the impacted stations and evaluation of these measures required the same effort in identification as the full multivariate community assessment. Measurement of total abundance was found to be a useful indicator of the most impacted conditions however, the same degree of station separation was achieved by evaluation of the annelid abundance alone. Measurement of organic matter levels was found to be more useful at Nubeena than at Meads Creek, as the high background levels at Meads Creek made it difficult to distinguish farm effects. However, the evaluation of organic matter was not simple, requiring laboratory preparation of samples before analysis. Measurement of redox showed greater potential as a farm-based technique, identifying most of those stations which had been identified as impacted by the full species level community assessment. However, individual measurements did not appear to provide as reliable an assessment of sediment condition as when used in combination with farm husbandry information. Thus it is suggested that redox measurement may prove more useful when conducted regularly and interpreted in association with farm management information as a time series of data. Similarly, aspects of the faunal composition, particularly assessment of annelid abundance and total *Capitella capitata* complex abundance, may prove to be worthwhile and simple indicators of farm condition.

Chapter 3 -
Temporal Variability in Benthic Community Structure and Sediment Condition under Salmon Cages.

3.1 Introduction

There have been many studies of the temporal effects of caged fish farming on the environment (eg. Brown et al, 1987; Frid and Mercer, 1989; Hargrave et al., 1993; Holmer and Kristensen, 1992; Lim, 1991; Lumb, 1989; Ritz et al, 1989; Wildish et al., 1993; Woodward et al., 1992) and several good review of these impacts are available (eg. Gowen and Bradbury, 1987; Rosenthal et al., 1988; DePauw and Joyce (eds), 1991; Iwama, 1991; Gowen and Rosenthal, 1993; Beveridge et al., 1994; Gowen, 1994; Wu, 1995). However, to date, these studies have tended to focus on either determination of the degree of impact (eg. Lumb, 1989; Weston, 1990; Johnsen et al., 1993; Krost, 1994), duration of impact (eg. Brown et al., 1987; Frid and Mercer, 1989; Ritz et al., 1989; Lim, 1991; Holmer and Kristensen, 1992; Wildish et al., 1993, Hargrave et al., 1993; Wu et al., 1994; Hargrave et al., 1997; Karakassis et al., 1998) or on techniques for compliance monitoring (Codling et al., 1995; Cochrane and Pearson, 1995). In this study the overall aim was to evaluate techniques which could be readily used by farm managers to assess the sediment condition on their leases.

As was discussed in Chapter 1, many techniques are not suitable for farm-based use. The spatial survey, described in chapter 2, further reduced the selection of techniques by rejecting those that were found to be inappropriate for local conditions. Thus, the methods that ultimately appeared to exhibit the greatest potential for farm-based application essentially address two main areas of investigation: 1) simple methods for evaluation of the faunal composition and 2) techniques for measurement of sediment oxygenation.

The methods identified for evaluation of faunal composition included assessment of total abundance levels, assessment of annelid abundance, *Capitella capitata* complex abundance and determination of species richness. Total faunal abundance has been

reported in many studies to increase markedly in association with increased inputs of organic material (Pearson and Rosenberg, 1979; Pearson et al., 1983; Grizzle, 1984; McIntyre, 1984; Horwitz and Blake, 1992) and this has also been shown to be the case with intensive finfish culture (Brown et al., 1987; Ritz et al., 1989; Weston, 1990 etc). Often the increased faunal abundance can be attributed to increased abundance of annelid worms particularly polychaetes (Pearson and Rosenberg, 1978; Brown et al., 1987; Weston, 1990) and, in cases of marked enrichment, more specifically as a result of the increase in abundance of opportunistic polychaetes such as *Capitella capitata* complex (Reish, 1972; Brown et al., 1987; Weston, 1990). Species richness has also been shown to reflect the gradient of organic enrichment, declining in association with increased organic deposition (Pearson and Rosenberg, 1979; Pearson et al., 1983; Grizzle, 1984; McIntyre, 1984; Horwitz and Blake, 1992).

During the spatial survey (Chapter 2) farm-based measurement of sediment oxygenation was shown to be most effectively achieved by measurement of the sediment redox potential, either as evaluation of the redox profile with depth through the sediment, by measurement of surface redox potential or by determination of RPD depth. As in several other studies (Pearson and Stanley, 1979; Frid and Mercer, 1989; Hargrave et al., 1997), redox measurement was shown to be a useful indicator of the deterioration in sediment condition. In a small number of studies redox measurement has not been found to be a particularly useful indicator of changing conditions (Brown et al, 1987; Weston, 1990; Wu et al, 1994), but this has generally occurred when conditions were only compared spatially and, as was observed during the spatial study (chapter 2), a one-off assessment of redox may not correlate well with the macrofaunal community structure. The spatial survey demonstrated that the outcome was unaffected regardless of whether redox measurement was conducted as a profile, surface measurement or as a RPD depth. However, it was suggested that description of the full redox profile was unnecessarily time consuming for use as a farm-based technique and that evaluation of the sediment surface redox level was likely to be subject to greater sources of variability as a result of localised surface effects such as single feed pellets or decomposing algal/detrital material.

There have been many studies examining seasonal effects on both the benthic community structure of soft sediments and the associated sediment chemistry (eg.

Jones, 1987; Morrissey et al., 1992; Hall, 1994; Olafsson et al., 1994) and some have evaluated these effects in relation to cage aquaculture locations (Brown et al., 1987; Holmer and Kristensen, 1992; Hargrave et al., 1993; Karakassis et al., 1998). The results of these studies have been variable. Marked seasonal differences in physical and chemical parameters (eg. dissolved oxygen, redox, sulphide, ammonia) were observed in some areas (Brown et al., 1987; Hargrave et al., 1993; Karakassis et al., 1998) but these differences were not necessarily reflected in the macrofauna (Brown et al, 1987).

Clearly, aspects of cage management, such as cage stocking densities and feed input, are likely to strongly influence the condition of sediments associated with cage culture operations. Thus it is likely that evaluation of farm management information, in association with the description of the biotic and physical-chemical factors may provide a useful framework for farmers wishing to relate the sediment condition to particular production regimes. Interestingly, associations of this nature have not previously been described.

During the present study, the accuracy and usefulness of each of the methods recommended by the spatial survey (Chapter 2) was examined relative to full evaluation of the benthic infaunal community structure at two cage stations and at a reference station. In order to achieve this objective, the study incorporated three components;

The methods were evaluated over 15 months to determine whether changing farm inputs associated with operational cages had any significant influence on the usefulness of the techniques.

The methods were further evaluated with the aim of detecting any seasonal changes in the community structure and to determine whether such seasonal changes could be distinguished from those arising from farm production practices.

Farm production information was incorporated into the analysis of the biotic, physical and chemical data in order to identify any relationships which could be used by farm mangers to either predict or manage the extent of any impact revealed by application of the selected techniques.

3.2 Materials and Methods

3.2.1 Location of Sampling Sites

Locations of the sample stations at Nubeena and Meads Creek are shown in figures 3.1 and 3.2 respectively. Tables 3.1 and 3.2 indicate the precise depths of the sample stations.

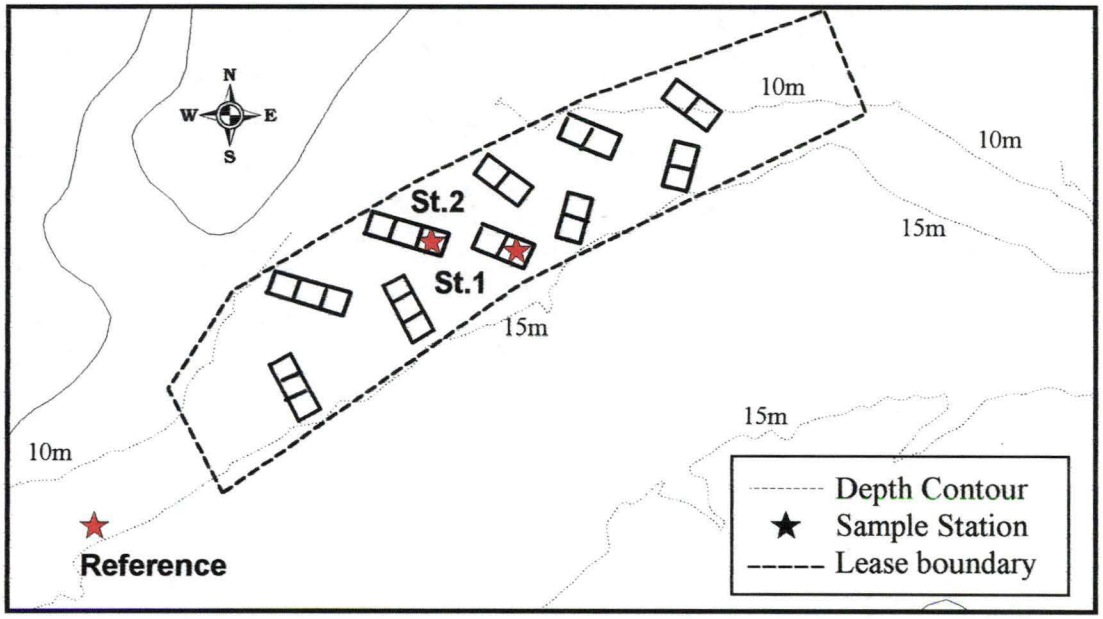


Figure 3.1 Map of the lease area at Nubeena showing position and depths of the sampling stations.

Table 3.1 Station codes, station identities and depths for sample stations included in the temporal survey at Nubeena.

Station	Station Identity	Depth (m)
1	Cage 1	13.2
2	Cage 2	13.1
3	Reference	13.4

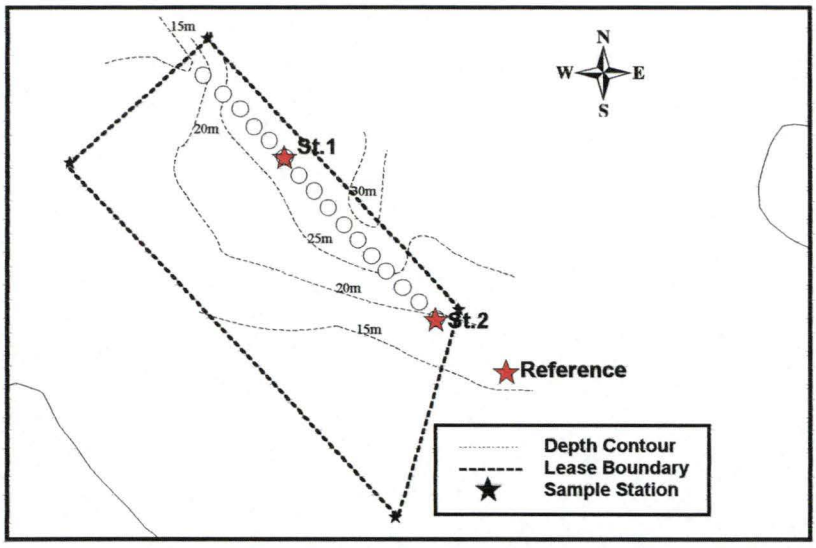


Figure 3.2 Map of Meads Creek site showing position of the sampling stations.

Table 3.2 Station codes, station identities and depths for sample stations included in the temporal survey at Meads Creek.

Station	Station Identity	Depth (m)
1	Cage 1	26.5
2	Cage 2	19.5
3	Reference	17.5

Samples were collected from both Nubeena and Meads Creek at approximately bi-monthly intervals over a period of 15 months (Table 3.3).

Table 3.3 Identification codes for temporal sampling at both Nubeena and Meads Creek.

Sampling Date		Month
Nubeena	**Meads Creek**	
13/12/93	16/12/93	0
1/2/94	26/1/94	2
19/4/94	20/4/94	4
8/6/94	7/6/94	6
16/8/94		8
13/9/94	14/9/94	9
20/11/94	21/11/94	11
26/1/95	24/1/95	13
21/3/95	23/3/95	15

3.2.2 Measurement of Redox Potential

Redox measurement (surface redox, depth profile, RPD depth) were carried out as previously described (Chapter 2).

3.2.3 Macrofaunal Analysis

All macrofaunal assessment and analysis was conducted as previously described (Chapter 2).

3.2.4 Statistical Analysis

Statistical analysis of the biotic, physical and chemical data was conducted as previously described (Chapter 2).

In addition two factor ANOVA was conducted on both diversity (abundance and species richness) and physical-chemical factors to determine whether significant differences existed between the sample stations over time. Where differences were identified post hoc testing (Tukey's Highest Significant Difference) indicated which stations and times contributed most to these differences.

3.3 Results

3.3.1 Macrofaunal Analysis - Nubeena

3.3.1.1 Multivariate Community Assessment

The dendrogram and MDS ordination plot resulting from the multivariate analysis of the community data for Nubeena are presented in figure 3.3. The primary dichotomy in cluster analysis appears to have divided the samples according to the extent of impact (Figure 3.3a). Group 1, on the basis of other indicators (i.e. association with active cages, low RPD depth), contained all of the unimpacted stations and some of the moderately impacted stations. Conversely, group 2 tended to reflect impacted conditions, containing all of the severely impacted stations and some of the moderately impacted stations. This separation and categorisation is supported by comparison of the faunal characteristics of the two groups.

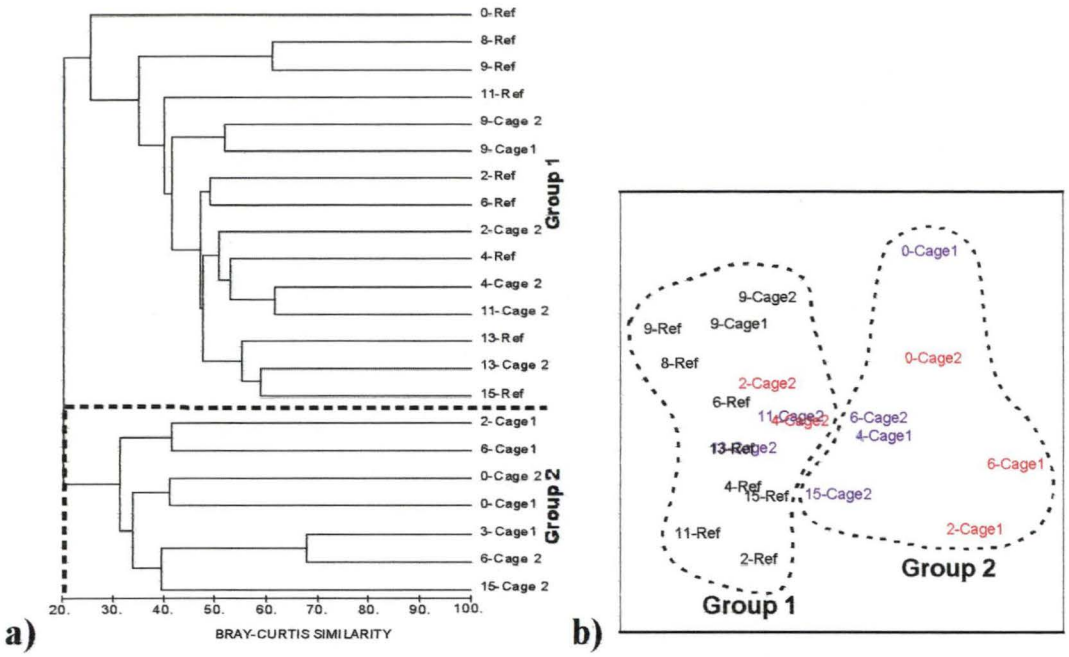


Figure 3.3 Nubeena species level identification a) Cluster analysis -Dendrogram b) MDS ordination plot (Stress=0.12). The numbers prefixed to the station identities indicate the time of sampling in months, refer table 3.3. All data √√ root transformed and replicates combined. Colour coding on the MDS ordination plot indicates the sample classification according to RPD depth results (black-undisturbed, blue - moderate impact and red - major impact).

SIMPER analysis at Nubeena (Table 3.4) indicated that group 1 (unimpacted) was not well characterised by any particular species. The three most common species, *Pista australis*, *Mediomastus australiensis* and *Lumbrinereis* sp., accounted for only 20% of the overall group similarity. In contrast, the group 2 (impacted) fauna was dominated by *Capitella capitata* complex, which accounted for 32% of the group similarity. Group 2 also had quite large numbers of the spionid polychaete, *Malacoceros tripartitus,* which contributed a further 16% to the group similarity.

The reference samples from the 0 month sample visit were found to have a markedly different crustacean fauna from the other sampling times, in that, larger numbers of cumaceans and ostracods were recorded. This may reflect an accidental sampling of an isolated swarm as these species were not recorded on subsequent visits and there was no evidence of other species which might be considered indicative of impact or disturbance.

Table 3.4 SIMPER output indicating a) and b) average abundance, ratio (average similarity/ st.dev. similarity), % similarity and cumulative % similarity of the six most important species in each of the main groups and c) average abundance, ratio (average dissimilarity/ st. dev. dissimilarity) and cumulative % dissimilarity of the six species which distinguish the main groups identified by cluster analysis.

	Species Name	Average Abundance	Ratio	Percentage Similarity	Cumulative % Similarity
a.	**Group 1**				
	Pista australis	123.83	3.48	7.59	7.59
	Mediomastus austaliensis	149.40	2.09	6.75	14.35
	Lumbrinereis sp.(Mov322)	24.85	2.23	5.18	19.52
	Capitellidae sp.2	24.69	1.58	4.64	24.16
	Brolgus tattersalli	46.06	1.62	4.62	28.78
b.	**Group 2**				
	Capitella capitata complex	2760.74	2.79	32.45	32.45
	Malacoceros tripartitus	131.48	3.94	16.02	48.47
	Neanthes cricognatha	70.00	1.17	9.96	58.43
	Leptochelia dubia	28.40	1.29	7.71	66.14
	Echinocardium cordatum	14.81	0.78	3.88	70.02

	Species Name	Group 2 Av.Abund.	Group 1 Av.Abund.	Ratio	Cumul. % Dissimilarity
c.	**Between Groups**				
	Capitella capitata complex	2760.74	470.23	1.61	4.87
	Malacoceros tripartitus	131.48	23.61	2.08	7.64
	Pista australis	6.17	123.83	1.83	10.06
	Mediomastus australiensis	12.35	149.40	1.44	12.23
	Brolgus tattersalli	0.00	46.06	2.19	14.40

The samples contained within group 2 (impacted) at Nubeena could be further separated one group comprising only two samples (Cage 1 at the 2 and 6 month sample times) can be distinguished (Figure 3.3a). These samples were highly dominated by *Capitella capitata* complex, indicating a severe disturbance. A further group contained the Cage 1 and cage 2 samples from the 0 month sample visit, and

this group can be considered moderately impacted in that the samples displayed large numbers of both *Capitella capitata* complex and *Malacoceros tripartitus*, as well as reduced species diversity. The final group contained the 4 month cage 1 sample, along with the cage 2 samples from 6 and 15 months. These samples, although not as strongly dominated by *Capitella capitata* complex and *Malacoceros tripartitus*, contained these species in greater numbers than normally encountered at the reference station. However, species diversity overall was relatively high at these stations indicating that although these samples were experiencing an impact, it was at a lower level than at the other groups. Consequently the three sub-groups reveal a gradient of increasing impact which is discernible as a progression from left to right across the ordination plot (Figure3.3b).

Generally, the cage 1 samples fell within the group 2 cluster with the exception of samples collected at 4 months, and cage 2 samples were only located within the group 2 cluster at the 0, 6 and 15 month sample visits. Assuming that the group 1 samples can be considered representative of unimpacted (or least impacted) conditions and the group 2 samples indicate conditions of varying impact, then the movement of cage stations between the two groups over the duration of the study could be considered indicative of periods of recovery and degradation. Cage 1 was classified as impacted at the start of the study but moved to the unimpacted category at the 9 month sample visit, where it then remained for the duration of the study. Cage 2 was also initially clustered within the impacted group however, at the 2 month sample visit this station was transferred to the unimpacted group indicating an improvement in benthic conditions. These conditions then appeared to deteriorate once again and at 6 months this cage once again returned to the impacted group. Similar changes were evident between 9 months and the final sample visit.

Superimposing the redox classifications (undisturbed - RPD depth>50mm (black), moderate impact - RPD depth = 10-50mm (blue) and major impact - RPD depth<10mm (red)) on the overall MDS representation (Figure 3.3b) revealed that all of the unimpacted stations were contained within group 1 whilst most of the severely impacted stations and moderately impacted stations were in group 2. ANOSIM of the infaunal composition of groups based on these redox categories (Table 3.5) indicated significant differences between the undisturbed group and both the moderately and

severely disturbed groups ($p<0.01$). However, there was no significant difference between the moderate and severely impacted groups.

Table 3.5 One-way ANOSIM of sample station groups based on redox (RPD depth) classification (group1-undisturbed, group 2 - moderate impact and group 3 - major impact).

Sample statistic (Global R): 0.443

Significance level of sample statistic: 0.3%

Groups Used	Statistical Value (R)	Significance Level
(1, 2)	0.620	0.2%
(1, 3)	0.415	1.8%
(2, 3)	-0.075	61.1%

Analysis of the reference data in isolation (cluster analysis/ordination – Appendix 3.1) suggested that there was a temporal gradient in the station separation. The summer/autumn samples tended to cluster together as did the spring/winter samples. However, no signs of such an effect were evident at the cage stations, where such seasonal effects may have been obscured by the effects of organic enrichment. The fauna described for the group 1 samples supports the assumption that these areas were unaffected by the farm cages. The vertical distribution of samples shown in the ordination plot (figure 3.3b) may represent another gradient of effect not clearly identified by the measured environmental variables e.g. depth, light penetration, sediment grain size.

3.3.1.2 Abundance – Biomass Comparison (ABC)

Assessment of ABC plots were conducted to validate the interpretation of impact determined by the multivariate assessment.

The ABC curves for the reference station (figure 3.4) reflected an undisturbed profile at all times except at 2 months when the curve suggested a moderate impact. This moderate impact appeared to be due to the change in abundance and biomass associated with the characterising species, *Mediomastus australiensis* and *Pista australis*. While a large number of species were recorded from this sample these two

species were represented by proportionately larger numbers of relatively small individuals explaining the low starting point for the biomass curve.

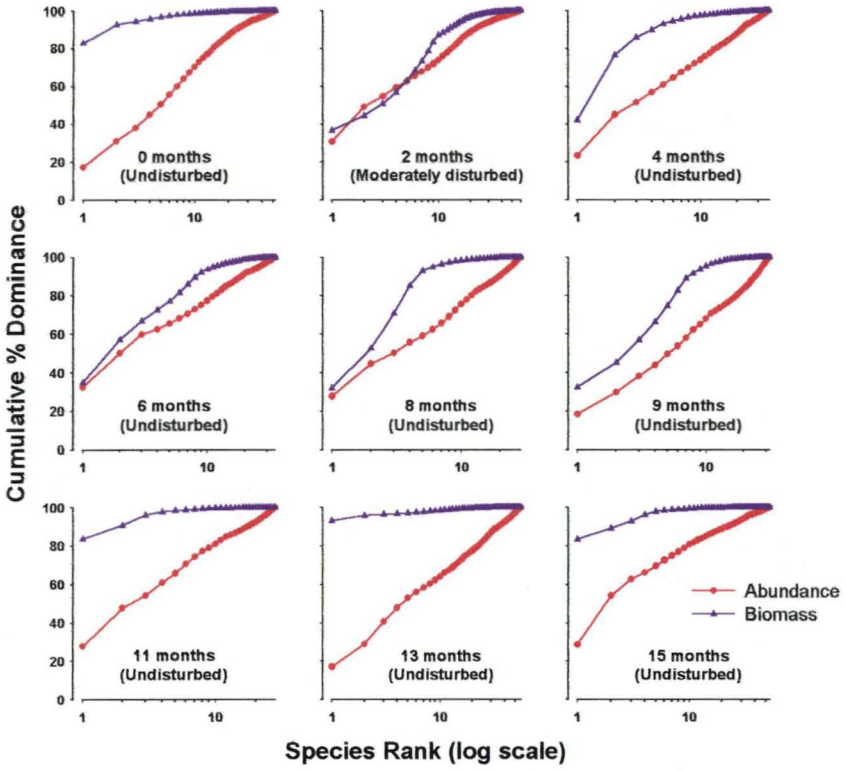


Figure 3.4 Nubeena – ABC curves for the reference station.

In contrast, the ABC plots for cage 1 at Nubeena (Figure 3.5) suggest that this station was disturbed at all of the sample times except the last sample visit. The profiles for cage 1 support the assessment of the full community structure.

The plots for cage 2 (Figure 3.6) indicated differing levels of disturbance over time at this station. The profiles generally indicated undisturbed conditions except at the first and last sample visits when conditions were classified as disturbed and moderately disturbed respectively. The ABC curves gave the same interpretation of cage condition as the multivariate analysis with the exception of the samples taken at the 6 month visit. At this time cage 2 was not identified as impacted by the ABC method, whereas in the MDS separation this sample was determined to be disturbed but was located in the intermediate area between the two main cluster groups (Figure 3.3b).

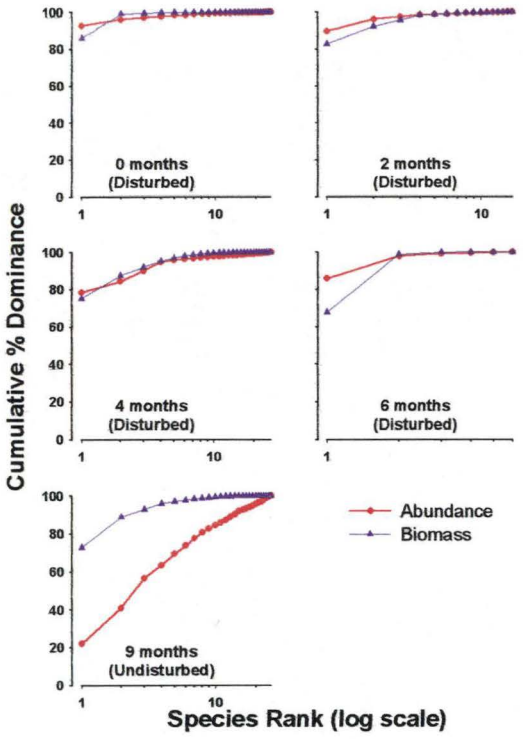


Figure 3.5 Nubeena – ABC curves for cage 1 over the temporal study period.

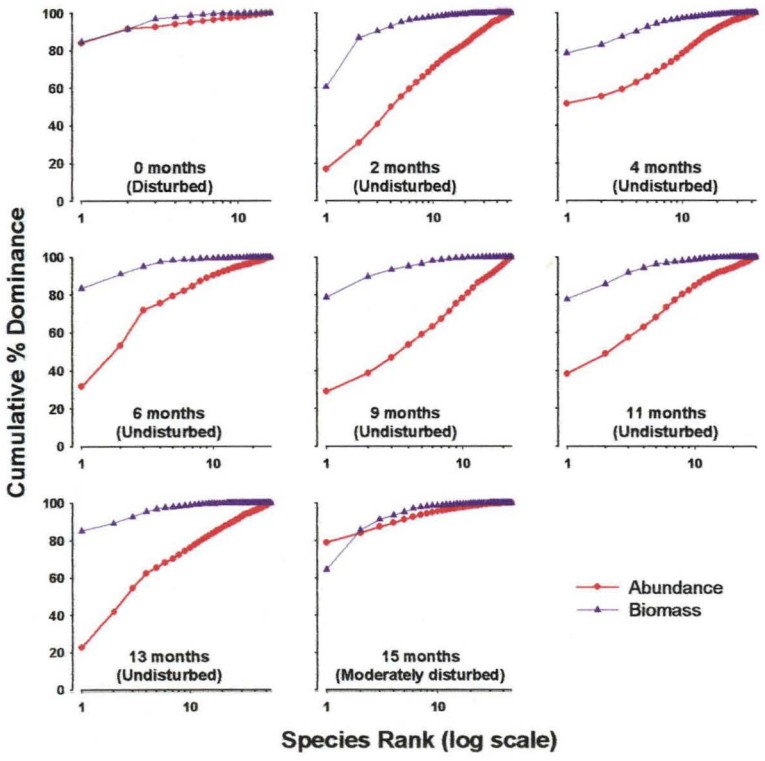


Figure 3.6 Nubeena – ABC curves for cage 2.

3.3.1.3 Assessment of Simple Macrofaunal Measures

Simple assessment of species diversity indices cannot be expected to distinguish the varying levels of impact as well as multivariate community assessment. However, it is possible that the main categories would be distinguishable. The number of species recorded from both the cage stations and reference station varied markedly over the study period (Figure 3.7). However at both cage 1 and cage 2, simple determination of the number of species clearly distinguished the most impacted samples. The reference station recorded lower numbers of species over the winter and spring sample times (months 6-11) than over the summer sample times, suggesting the existence of a seasonal pattern for species richness.

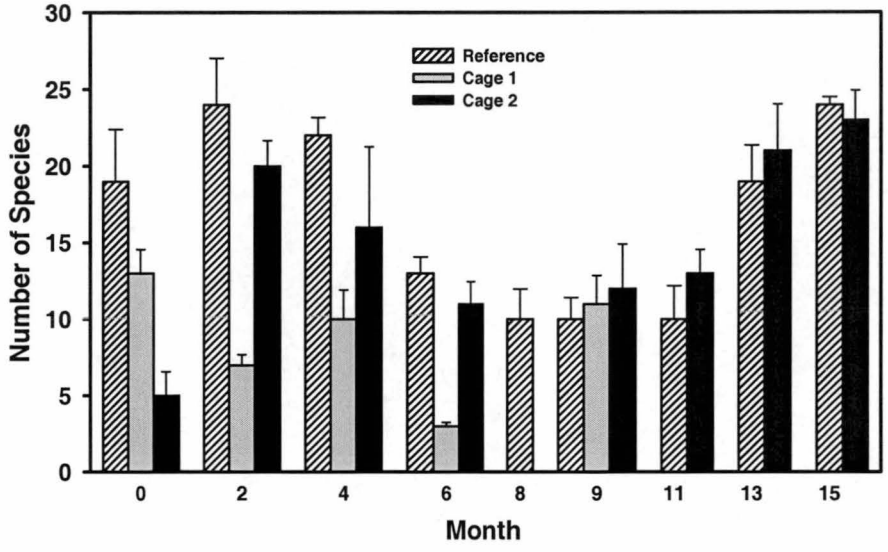


Figure 3.7 Nubeena – Number of species (+ s.e.) for all sample stations over the temporal study. Note that cage 1 was only studied until the 9th month of sampling.

ANOVA of species number (Table 3.6) indicated a significant interaction between time and station. Post hoc assessment (pairwise comparisons, Appendix 3.2) reflected the marked differences over time at the reference station with a significantly higher number of species being recorded in the samples taken at 2 and 4 months than those taken at 8, 9 and 11 months ($p<0.05$). The samples taken at 2 months also had a significantly higher number of species than those taken at 6 months ($p<0.05$) and similarly, the number of species recorded at 15 months was significantly higher than at 8, 9 or 11 months ($p<0.05$). The number of species recorded from cage 1 was significantly lower than the corresponding reference

conditions at the 2 ($p<0.01$), 4($p<0.05$) and 6 month ($p<0.05$) sample visits. However, at cage 1 the species numbers did not vary greatly over time. The post hoc assessments for cage 2 indicated that this station only differed significantly from the reference at the first sample visit (0 months), when a markedly lower number of species was recorded ($p<0.05$). The number of species recorded from cage 2 differed markedly over time and was significantly lower at the 0 month visit than the 2, 13 or 15 month visits ($p<0.01$).

Table 3.6 ANOVA for species richness data for all stations at Nubeena. The cage stations were analysed separately because the duration of sampling differed.

a. Cage 1 & Ref	df	MS	F-ratio	P
Time	4	113.450	7.125	<0.001
Station	1	866.866	54.444	<0.001
Time*Station	4	124.142	7.797	<0.001
Error	36	15.922		

b. Cage 2 & Ref	df	MS	F-ratio	P
Time	7	3.225	7.132	<0.001
Station	1	3.843	8.498	0.005
Time*Station	7	0.991	2.192	0.048
Error	58	0.452		

Total abundance (Figure 3.8) showed a marked variation over time at the cage stations. At the reference stations total faunal abundance was not as variable, however, the data does indicate a similar seasonal pattern to that observed for species richness. The data indicate a reduction in total abundance associated with the winter/spring sample periods (6-11 months). Neither of the cage stations showed patterns of temporal variation corresponding to that seen at the reference station. Abundance at cage 1 was elevated at the 0 month sample visit and was also high for the 2, 4 and 15 month sample visits. Total faunal abundance for cage 2 did not vary as noticeably over time but was still clearly elevated at the 15 month sample visit.

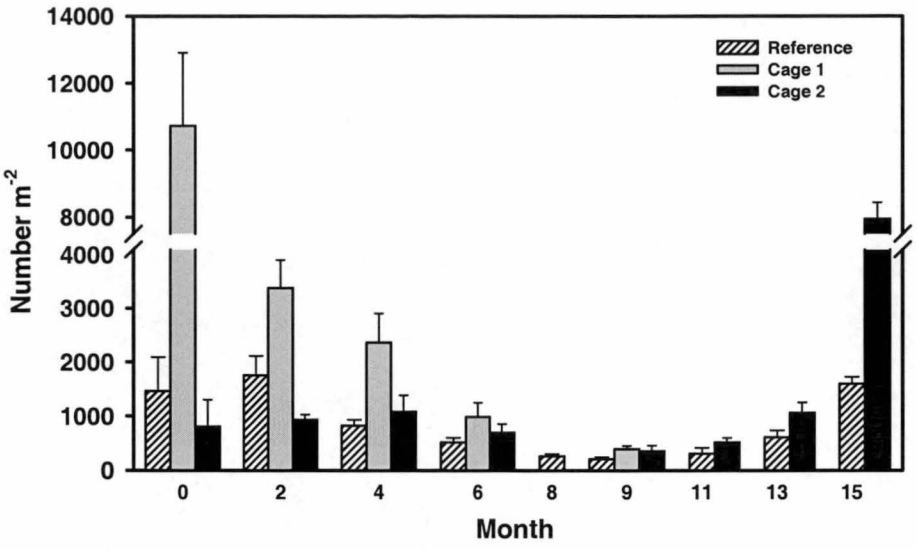


Figure 3.8 Nubeena – Total abundances (+ s.e.) for all sample stations over the temporal study. Note that cage 1 was only studied until month 9.

ANOVA of the total abundance data (Table 3.7) identified the interaction between time and station to be highly significant, $p<0.01$. Pairwise comparisons (Appendix 3.3) for the reference station revealed that at 2 months the total abundance was significantly higher than that recorded at 9 or 11 months ($p<0.05$). Cage 1 exhibited a continual decline in abundance over the duration of the study from an extremely high abundance level at 0 months, this initial abundance level being significantly different to that observed at all other sample times ($p<0.01$). The faunal abundance at cage 2 was also significantly elevated at the 15 month sample visit ($p<0.01$). There were no other instances where the cage stations were significantly different from the corresponding reference stations.

Annelid abundance (Figure 3.9) followed the same trends as total abundance. A seasonal reduction in abundance at the reference stations was indicated, although this was not as clear as with the full fauna due to the reduced numbers. Cage 1 showed a steady decline in annelid abundance from the initial sample visit until 9 months, whilst cage 2 indicated no obvious changes until 15 months when a marked increase was observed. Generally evaluation of annelid abundance alone identified the same stations as impacted as were distinguished by total abundance.

Table 3.7 ANOVA of the total abundance data for a) Reference station and cage 1 and a) reference station and cage 2 at Nubeena. Cage stations were treated separately because the duration of sampling was different.

a. Cage 1 & Ref.	df	MS	F-ratio	P
Time	4	4.558E+07	21.161	<0.001
Station	1	7.654E+07	35.535	<0.001
Time*Station	4	2.974E+07	13.806	<0.001
Error	36	2154070.122		

b. Cage 2 & Ref.	df	MS	F-ratio	P
Time	7	1.871E+07	50.901	<0.001
Station	1	1.048E+07	28.517	<0.001
Time*Station	7	1.187+07	32.287	<0.001
Error	58	367669.401		

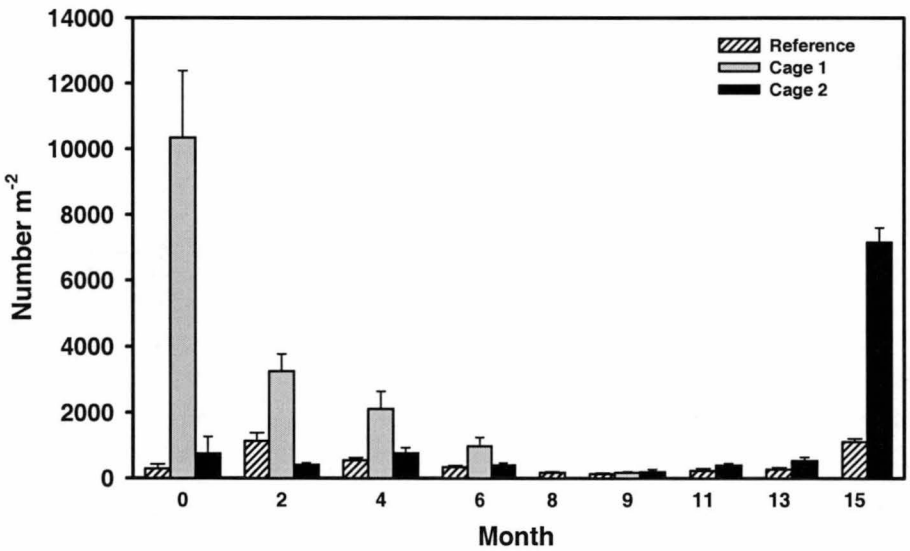


Figure 3.9 Nubeena – Annelid abundance (+ s.e.) for all sample stations over the temporal study. Note that cage 1 was only studied until the 9 month sampling.

The differences between the stations were further assessed using ANOVA (Table 3.8) where again, the interaction between time and station was highly significant.

Post hoc testing (Appendix 3.4) showed that there were no significant differences between the reference stations over the sample period. The pairwise comparisons also indicated that annelid abundance at cage 1 (Appendix 3.4a) declined markedly over the study period. The abundances recorded at the first two sample visits (0 and 2 months) at cage 1 were significantly higher than those at the reference stations at the corresponding times ($p<0.01$). Annelid abundance at cage 2 (Appendix 3.4b) was significantly different from the reference station at the last sample visit only (15 months, $p<0.01$).

Table 3.8 ANOVA of the annelid abundance data for a) reference station and cage 1 and a) reference station and cage 2 at Nubeena. Cage stations were treated separately because the duration of sampling was different.

a. Cage 1 & Ref.	df	MS	F-ratio	P
Time	4	2.017E+06	14.694	<0.001
Station	1	9.109E+06	66.369	<0.001
Time*Station	4	1.920+06	13.993	<0.001
Error	36	137246.100		

b. Cage 2 & Ref.	df	MS	F-ratio	P
Time	7	1.541E+07	73.630	<0.001
Station	1	1.205E+07	57.606	<0.001
Time*Station	7	1.025+07	49.004	<0.001
Error	58	209227.425		

The overall pattern of abundance of *Capitella capitata* complex at Nubeena was found to be very similar to that displayed by both annelid and total abundances (Figure 3.10). Very low numbers of *Capitella capitata* complex were recorded from the reference stations at both the initial sample visit and at 15 months. In contrast, cage 1 exhibited very high abundances of *Capitella capitata* complex at the first sample visit which then declined at each subsequent sample visit. It was absent at the last sample visit (9 months). Cage 2 displayed low levels of *Capitella capitata* complex at all times, except the 15 month sample visit when the abundance was very high.

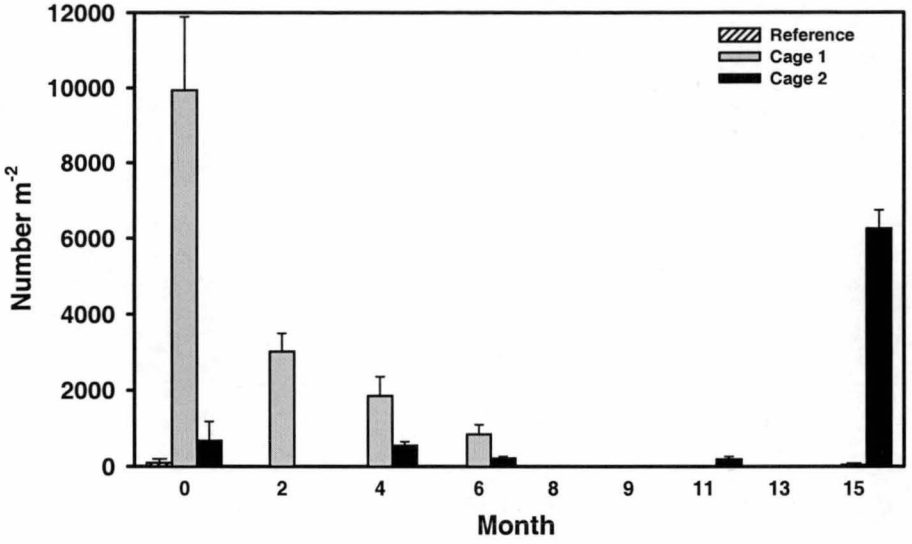


Figure 3.10 Nubeena – Number m^{-2} of *Capitella capitata* complex (+ s.e.) for all sample stations over the temporal study. Note that cage 1 was only studied until the 9 month sampling.

Once again ANOVA of the abundance of *Capitella capitata* complex (Table 3.9) indicated a significant interaction between time and station for both cage 1 and cage 2. The subsequent pairwise comparisons (Appendix 3.5a) revealed that samples from

Table 3.9 ANOVA of the *Capitella capitata* complex abundance data for a) Reference station and cage 1 and a) reference station and cage 2 at Nubeena. Cage stations were treated separately because the duration of sampling was different.

a. Cage 1 & Ref	df	MS	F-ratio	P
Time	4	3.394E+07	21.595	<0.001
Station	1	1.081E+08	68.773	<0.001
Time*Station	4	3.248E+07	20.663	<0.001
Error	36	1571826.121		

b. Cage 2 & Ref.	df	MS	F-ratio	P
Time	7	1.042E+07	58.842	<0.001
Station	1	1.685E+07	95.130	<0.001
Time*Station	7	1.016+07	57.359	<0.001
Error	58	177172.116		

cage 1 at 0 and 2 months were significantly different to the equivalent reference conditions ($p<0.01$). At cage 2 the numbers of *Capitella capitata* complex were generally low, with the only significant difference to the equivalent reference conditions occurring at 15 months.

3.3.2 Redox Potential Measurement - Nubeena

The redox profiles from the reference stations showed no indication of impact at any sample visit (Figure 3.11) and all profiles were very similar. Generally the redox potential remained positive throughout the profile, dropping below zero on only a few occasions in association with the deepest readings. At cage 1 the redox profiles suggested an impact at 0, 2, 4 and 6 months. In each case the redox potential decreased rapidly with depth and was negative at or near the surface. At 2 and 6 months the sediment was anoxic at the surface. Similarly, at cage 2, the RPD also approached the sediment surface at 0, 2 and 4 months. Furthermore, at 6 and 15 months the redox profiles suggested that a slight impact was occurring as the sediments were anoxic nearer to the surface. The redox profile for cage 2 appeared somewhat erratic at 11 months in that the sediment became anoxic at approximately 40 mm but apparently recovered again below this depth. There was considerable variability in the profiles for each of the three replicate cores for cage 2 at the 11 month sample visit and this may account for the apparently anomalous combined profile.

The values recorded for sediment surface redox potentials (Figure 3.12) at the reference stations were fairly constant (350 – 400 mV), although there appeared to be a slight reduction in the earliest samples. ANOVA (Table 3.11) indicated a highly significant interaction between time and station. Pairwise comparisons (Appendix 3.6) indicated that at the reference station surface redox levels did not differ significantly over time. However, at cage 1 surface redox measurements showed a significant reduction at both the 2 and 6 month sample visits, (Figure 3.12, $p<0.01$). At cage 2 the surface redox was significantly reduced at the initial sample visit and at 2 and 4 months ($p<0.05$). The surface redox was also slightly reduced at 11 months but this reduction was not significant.

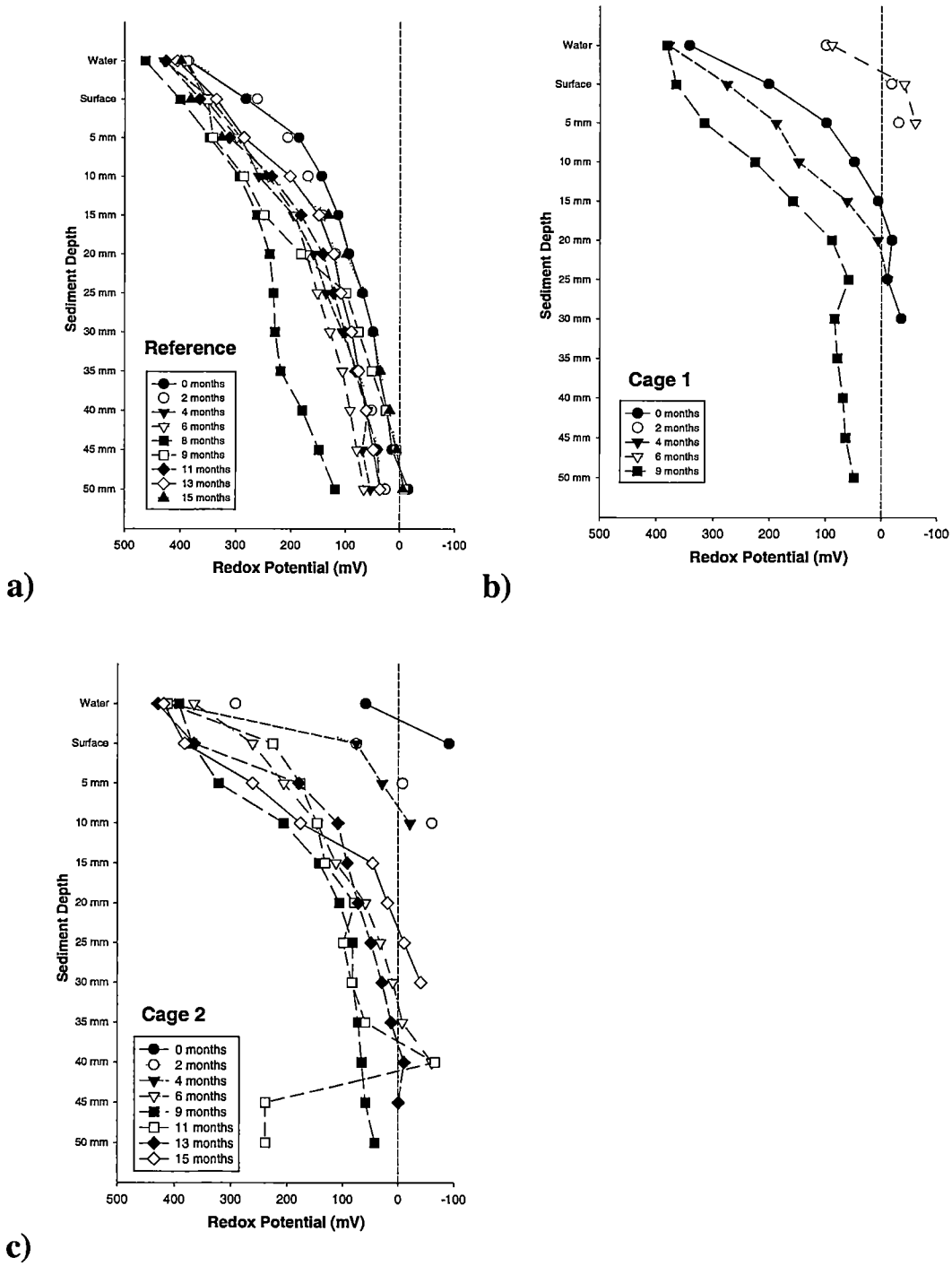


Figure 3.11 Redox potential profiles for Nubeena a) reference, b) cage 1 and c) cage 2. Values are an average of the three replicates.

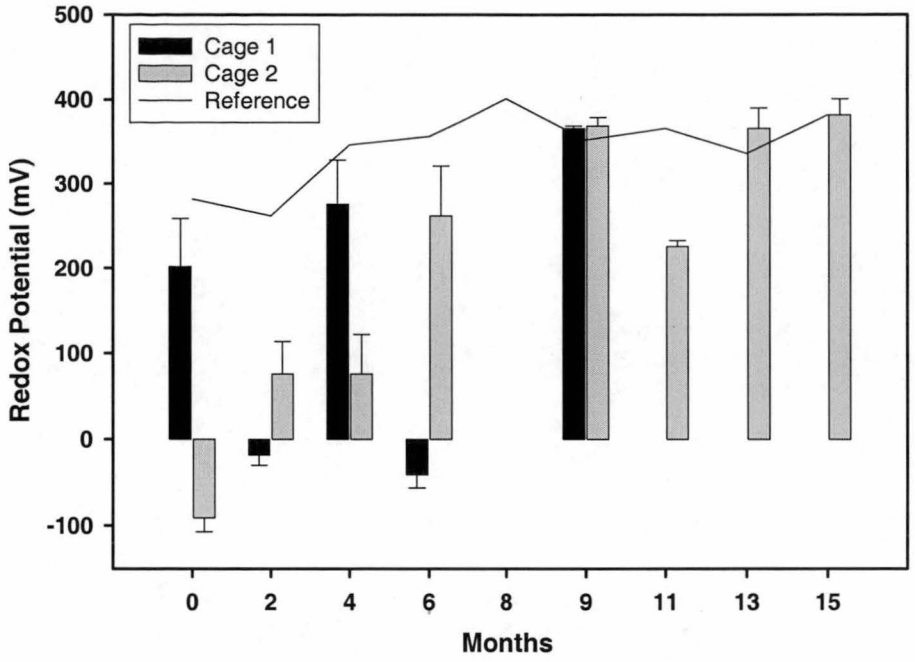


Figure 3.12 Sediment surface redox potential (+ s.e.) for all stations at Nubeena. Note that cage 1 was only studied until September 94.

Table 3.11 ANOVA of the sediment surface redox potential data for a) reference station and cage 1 and b) reference station and cage 2 at Nubeena. Cage stations were treated separately because the duration of sampling was different.

a. Cage 1 & Ref.	df	MS	F-ratio	P
Time	4	59738.333	14.972	<0.001
Station	1	198453.333	49.738	<0.001
Time*Station	4	43095.000	10.801	<0.001
Error	20	3990.000		

b. Cage 2 & Ref.	df	MS	F-ratio	P
Time	7	63099.702	17.887	<0.001
Station	1	193802.083	54.939	<0.001
Time*Station	7	31587.798	8.594	<0.001
Error	32	3527.604		

At the Nubeena reference site, the RPD depth tended to be stable, rarely rising above 50 mm and never above 45 mm over the duration of the study. In contrast, the values for cage 1 and 2 varied markedly over the study period (Figure 3.13). ANOVA (Table 3.12) indicated that there was a highly significant interaction between time and station. Pairwise comparisons (Appendix 3.7) showed that the RPD depth did not change significantly over time at the reference station (Figure 3.13) whereas, at cage 1 a significant reduction ($p< 0.01$) in the RPD depth was evident at 2 and 6 months; in fact the RPD depth was almost at the surface at these times. The RPD level was also found to be significantly reduced at the 0 and 4 month sample visits, relative to the corresponding reference samples ($p<0.01$). There appeared to be a period of recovery between the 6 and 9 month visits as the RPD level at 9 months was once again similar to that observed at the reference station. The RPD depth measurements at cage 2 were also similar to the reference at 9, 11 and 15 months. However, the RPD was at the surface at the initial sample visit and again approached the surface at 2, 4, 6 and 15 months. At each of these times RPD was significantly different from the corresponding reference values ($p<0.01$).

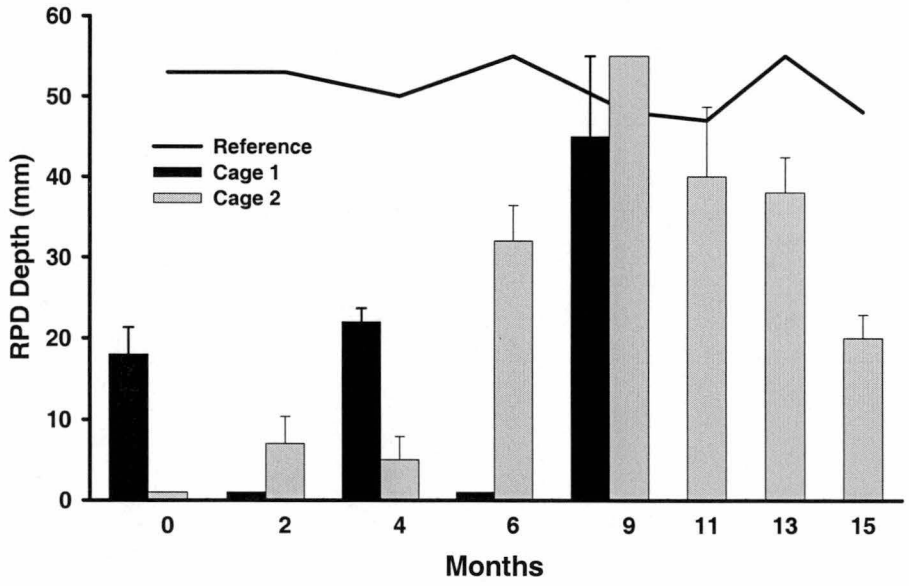


Figure 3.13 RPD depth (+ s.e.) for all stations at Nubeena. Note that cage 1 was only studied until month 9.

Table 3.12 ANOVA of the RPD depth data for a) reference station and cage 1 and b) reference station and cage 2 at Nubeena. Cage stations were treated separately because the duration of sampling was different.

a. Cage 1 & Ref.	df	MS	F-ratio	P
Time	4	392.917	7.992	0.001
Station	1	9187.500	186.864	<0.001
Time*Station	4	668.750	13.602	<0.001
Error	20	49.167		

b. Cage 2 & Ref.	df	MS	F-ratio	P
Time	7	545.238	13.596	<0.001
Station	1	8533.333	212.779	<0.001
Time*Station	7	658.333	16.416	<0.001
Error	32	1283.333		

3.3.3 Farm Data Assessment - Nubeena

The biomass of fish associated with cage 2 (Figure 3.14) was greatest in mid July 94. This cage was emptied on three occasions during the study: i) a 4 week period in March 94, ii) a 9 week period in August/September 94 and iii) a 5 week period in November/December94. The weekly feed input to cage 2 varied considerably but averaged around 1.5 - 2.0 tonnes. Feed input tended to be reduced over the summer months and prior to harvest and was generally more stable over the winter months.

There was no clear correlation between the macrofaunal community structure and either the farm feed or the fish biomass records. However, there does seem to be a general trend whereby large fish biomass and/or high feed input was associated with a disturbed community structure. This inverse relationship with community health was more evident in relation to feed input than to fish biomass (Figure 3.15).

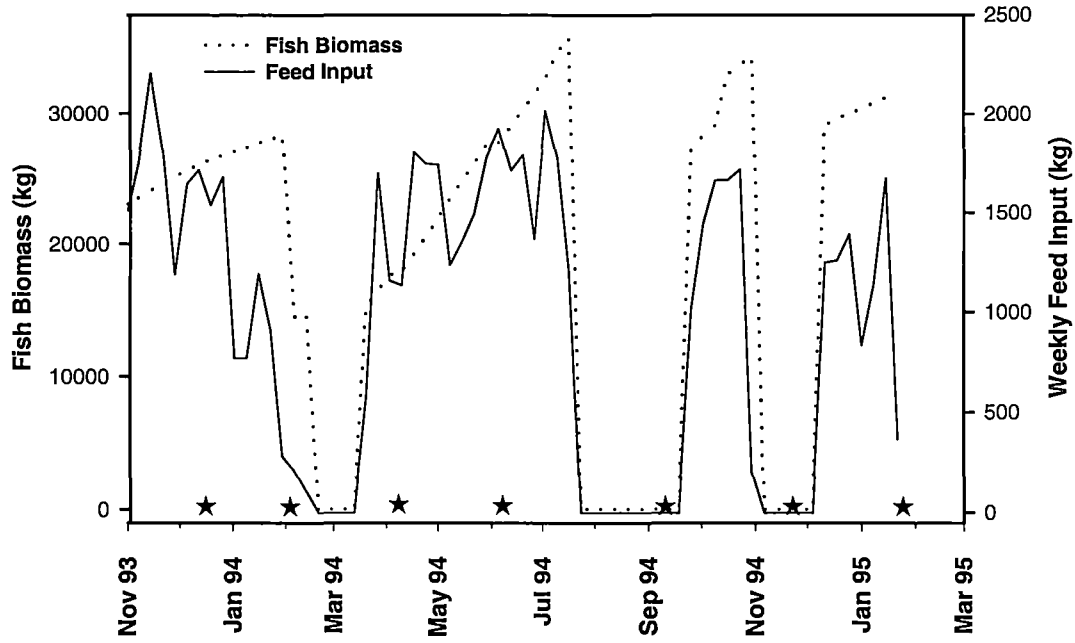


Figure 3.14 Feed input (kg) and fish stocking levels (kg) for cage 2 at Nubeena over the duration of the temporal survey. ✶ indicates sample point (0-13 months).

Farm data for cage 1 was only available until the end of January 1994. Consequently, on the ordination plots (Figure 3.15) the two cage 1 samples for the 4 and 6 month sample visits appear as points in group 2. In addition three medium sized circles corresponding to cage 2 at the 2, 4 and 13 month sample visits appear in group 1. The feed information for cage 2 indicates that the feed input had been declining over the 2 months preceding the 2 month sample visit. Therefore, while feed input may still have been relatively high, the organic load was diminishing. Similar circumstances also occurred on several occasions in January 95. In contrast, in April 94 restocking had just taken place. Therefore, while feed inputs were substantial, the benthic community may not yet have had sufficient opportunity to adapt to reflect this increased organic load. There are two instances on the fish biomass plot (Figure 3.15b) where large circles can be seen in group 1 (cage 2 at 2 months and at 13 months), in both cases the explanation relating to feed input applies. There were two other samples in group 1 (the unimpacted group) which showed moderately large circles (cage 2 at 4 months and at 11 months). At 4 months this cage had only recently been stocked and therefore the macrofaunal community would not yet have had sufficient time to fully reflect the degraded conditions. While the samples taken at 11 months were taken after the cage location had been fallowed for a period of 3

weeks, over which time the macrofaunal community would have recovered to some extent.

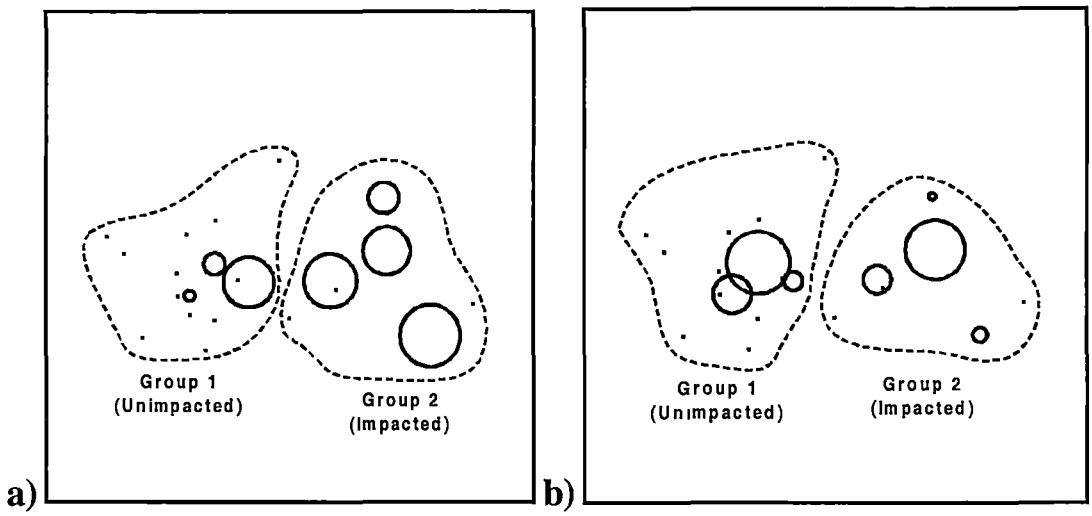


Figure 3.15 Nubeena - MDS Ordination plot (Stress=0.12) showing impacted and unimpacted groups with farm data included a) mean feed input and b) mean fish biomass over the 4 weeks prior to sampling. Circle diameter increases with increasing feed input.

The relationship between the benthic community structure and measurement of redox was much clearer than the relationship to farm production data. Group 1 (unimpacted) samples largely corresponded to redox measures indicative of well oxygenated sediments (high surface redox potential/ deep RPD level) and conversely the group 2 samples generally related to redox measures reflecting impacted sediments (Figure 3.16a & b). Here again, the two smaller circles in group 1 correspond to cage 2 at 2 and 4 months. Four samples in group 2 were represented by larger circles (cage 1 at 0 and 4 months and cage 2 at 6 and 15 months). Feed input was reduced at cage 1 over the summer period and this may account for the better than expected redox results at initial sampling. Farm data were only available for cage 1 until the end of January 94 and therefore it is not possible to explain the improved redox conditions at cage 1 at 4 months (April 94). The samples from cage 2 at 15 months were taken just after harvest, consequently, the redox conditions are likely to have recovered fairly rapidly whereas the macrofaunal community may not yet have had sufficient time to achieve the same level of recovery. The samples at 6 months were taken in the middle of a stocking cycle and no explanation could be

found in the farm data for the improved redox conditions at this time. The equivalent plot showing the RPD depth results (Figure 3.16b) indicates a similar pattern.

As circle size is representative of the redox potential, the circles become smaller (points) towards the right hand side of both plots (Figure 3.16), suggesting that the impact increases from left to right. This outcome agrees with the situation already described by the macrofaunal assessment. RPD depth appears to be more consistent than surface redox potential at displaying the difference between the group 1 (impacted) and group 2 (unimpacted) samples.

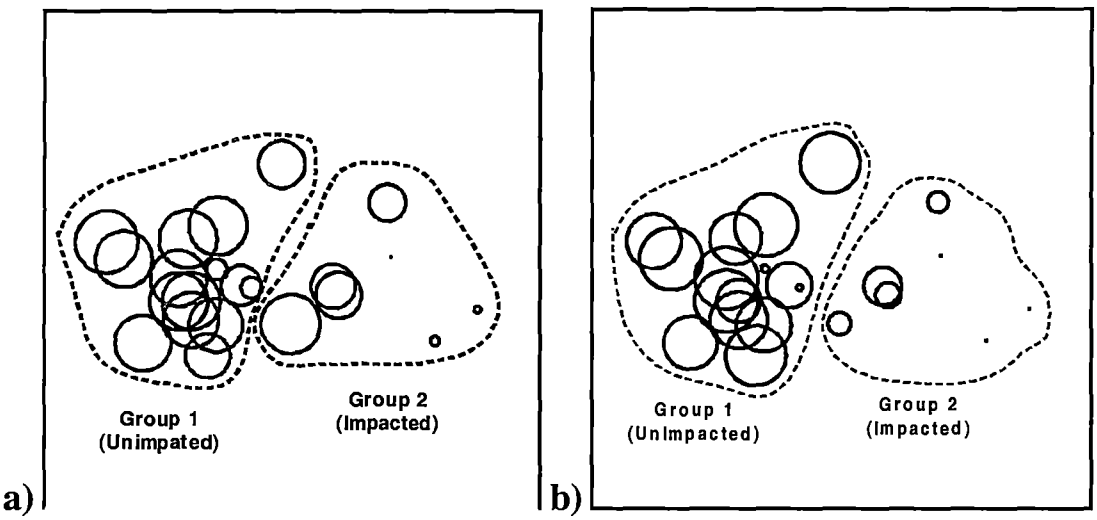


Figure 3.16 Nubeena - MDS Ordination plot (Stress=0.12)) showing impacted and unimpacted groups with redox data included, a) surface redox results and b) RPD depth results. Circle diameter increases with improving redox condition.

3.3.4 Macrofaunal Analysis – Meads Creek

3.3.4.1 Multivariate Community Assessment

At Nubeena the primary dichotomy in cluster analysis occurred at a sample similarity level of approximately 20%. In contrast, at Meads Creek the two primary cluster groups were separated at a much lower level of similarity (13%, Figure 3.17a). The differences between the groups are quite marked and subsequent separation of samples within the resulting groups does not occur until similarity levels of 30% or greater. All of the reference samples clustered within group 1, suggesting that the two primary groups reflect unimpacted (group 1) and impacted (group 2) conditions.

Consequently, there was less overlap between the impacted and unimpacted conditions at Meads Creek.

As the sediment at Meads Creek was generally finer than at Nubeena (Appendix 2.3 and 2.5) the fauna at this site might be expected to be pre-adapted to the increased levels of sedimentation associated with such environments. In this context, the brittle star *Amphiura elandiformis* was the most common species recorded at Meads Creek, accounting for about 8% of the group similarity (SIMPER analysis, Table 3.13). This species feeds both on detritus, by actively consuming particles on the sediment surface, and by partially burying itself in the sediment and using its arms to capture suspended organic material from the water column. Other species that were commonly found in the group 1 samples at Meads Creek were also burrowing or surface deposit feeders (Nemertea sp (6.6%), *Mediomastus australiensis* (6.2%), *Lysilla jennacubinae* (5.6%)). One such is *Lysilla jennacubinae,* a surface deposit feeder which spreads its tentacle over the sediment surface to trap depositing organic material. While tolerant of, if not reliant on, the deposition of organic material for nourishment, these species are likely to be inhibited or smothered by very high levels of organic deposition and would therefore be expected to be reduced in, or excluded from, cage samples.

The reference samples generally formed a fairly compact subgroup within group 1, with the exception of the reference sample at the initial sample visit. Although not significantly different from all of the other reference samples, this sample displayed a greater number of species than many of the subsequent sample visits. Three of the main faunal differences encountered at this time were 1) large numbers of a small burrowing anenome (cf *Edwardsia* sp), 2) large numbers of the burrowing detritivorous polychaete, *Lumbrinereis* sp. and 3) low levels of the little dog whelk, *Nassarius nigellus*. Furthermore, the brittle star *Amphiura elandiformis,* a species that was identified as being important for distinguishing between impacted and unimpacted samples, was also recorded in slightly lower numbers from the reference station at the first visit. Together these differences were sufficient to separate the first sample time from subsequent sample times. However, the changes were not large enough to suggest impact, demonstrating the sensitivity of multivariate techniques to natural variation.

Comparison with RPD depth categorisation showed that at Meads Creek only one of the group 1 stations could be categorised by redox as severely disturbed (cage 1 at the initial visit) and that only one station in group 1 appeared moderately impacted (cage 2 at 2 months).

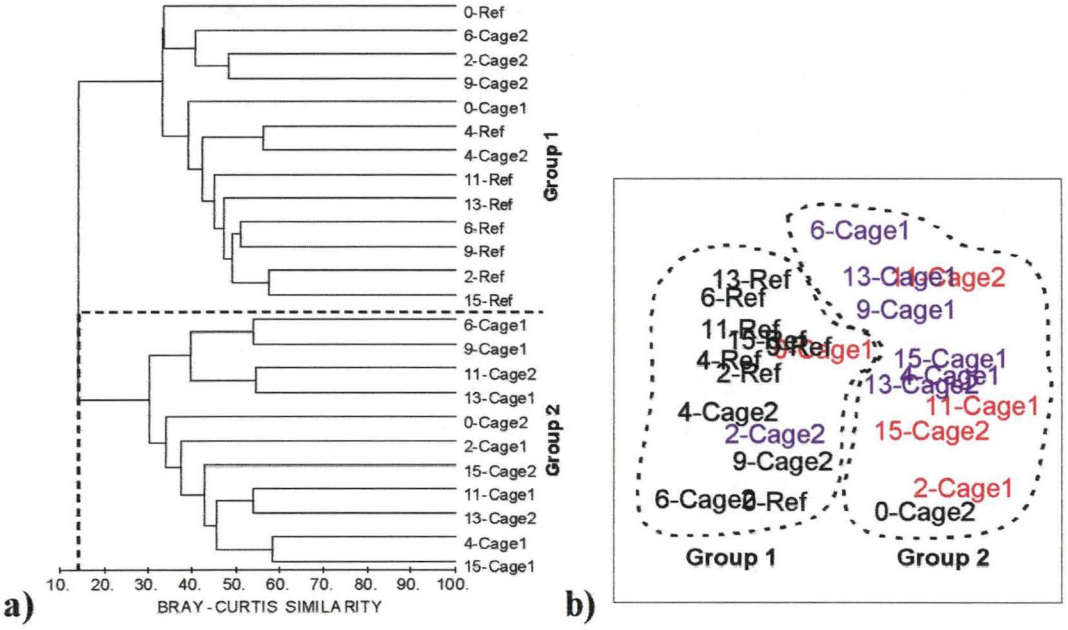


Figure 3.17 Meads Creek species level identification a) Cluster analysis - Dendrogram b) MDS ordination plot (Stress=0.14). The numbers prefixed to the station identities indicate the time of sampling in months, refer table 3.3. All data √√ root transformed and replicates combined. Colour coding on the MDS ordination plot indicates the sample classification according to RPD depth results (black-undisturbed, blue - moderate impact and red - major impact).

Like those at Nubeena the group 2 samples at Meads Creek, were characterised by *Capitella capitata* complex, with the addition of *Maoricolpus roseus,* an extremely successful introduced opportunistic gastropod (SIMPER analysis, Table 3.13). *Capitella capitata* complex accounted for 42% of the within group similarity and *Maoricolpus roseus* for 10%. Consequently, together these species accounted for 52% of the overall group similarity. Again the presence of these species suggests that the samples associated with group 2 were highly influenced by the deposition of organic material from the cages.

The cage 1 samples were generally clustered within group 2 (impacted) with the exception of the first sample visit (0 months), whereas the samples from cage 2 moved between the two groups and were only included in group 2 at the first sample visit, and at 11, 13 and 15 months.

Table 3.13 SIMPER output indicating a) and b) average abundance, ratio (average similarity/ st.dev. similarity), % similarity and cumulative % similarity of the six most important species in each of the main groups and c) average abundance, ratio (average dissimilarity/ st. dev. dissimilarity) and cumulative % dissimilarity of the six species which distinguish the main groups identified by cluster analysis.

	Species Name	Average Abundance	Ratio	Percentage Similarity	Cumulative % Similarity
a.	**Group 1**				
	Amphiura elandiformis	657.630	1.69	7.88	7.88
	Nemertea sp.	260	2.00	6.61	14.49
	Mediomastus australiensis	617.926	1.78	6.25	20.74
	Lysilla jennacubinae	299.704	1.43	5.65	26.39
	Lumbrinereis sp. (MoV322)	281.926	1.45	5.36	31.75
b.	**Group 2**				
	Capitella capitata complex	13753.037	1.73	42.14	42.14
	Maoricolpus roseus	629.481	0.67	10.05	52.19
	Nemertea sp.	185.629	0.92	9.51	61.70
	Simplisetia amphidonta	134.074	0.94	9.28	70.98
	Neanthes cricognatha	151.259	0.70	6.52	77.50

	Species Name	Group 2 Av.Abund.	Group 1 Av.Abund.	Ratio	Cumul. % Dissimilarity
c.	**Between Groups**				
	Capitella capitata complex	13753.037	25717.778	1.25	6.30
	Amphiura elandiformis	35.852	657.630	1.82	9.45
	Mediomastus australiensis	8	617.926	1.95	12.14
	Maoricolpus roseus	629.037	850.963	1.09	14.74
	Lysilla juennacubinae	0	299.704	1.97	17.23

As was observed at Nubeena the MDS ordination plot for the Meads Creek data (figure 3.17b) appears to reflect a gradient of relative disturbance, with the most impacted samples occurring on the far right of the plot. However, though the separation between the primary cluster groups appeared to be clearer at this site than at Nubeena, this trend was not as obvious. In particular, there was less differentiation within the unimpacted samples.

ANOSIM of the groups on the basis of their redox categories (Table 3.14) indicated significant differences in the community structures between the undisturbed redox group and both the moderately and severely disturbed groups, however there was no significant difference between the moderately and severely impacted groups.

Table 3.14 One-way ANOSIM of sample station groups based on redox classification (group 1-undisturbed, group 2 - moderate impact and group 3 - severe impact).

Sample statistic (Global R): 0.670

Significance level of sample statistic: 0.0%

Groups Used	Statistical Value (R)	Significance Level
(1, 2)	0.697	0.2%
(1, 3)	0.918	0.0%
(2, 3)	-0.054	63.5%

3.3.4.2 Abundance – Biomass Comparison (ABC)

The ABC curves for the reference station at Meads Creek indicate an absence of impact at all times (Figure 3.18). However, the curves for cage 1 (Figure 3.19) suggest that there was a moderate level of disturbance at the 2, 4, 9 and 11 month sample visits whilst at 15 months, the community associated with this station was severely disturbed. At cage 2 there was also evidence of severe disturbance at the 11 month sample visit whilst, at the initial sampling and at 2, 11 and 13 months, conditions were only moderately disturbed (Figure 3.20).

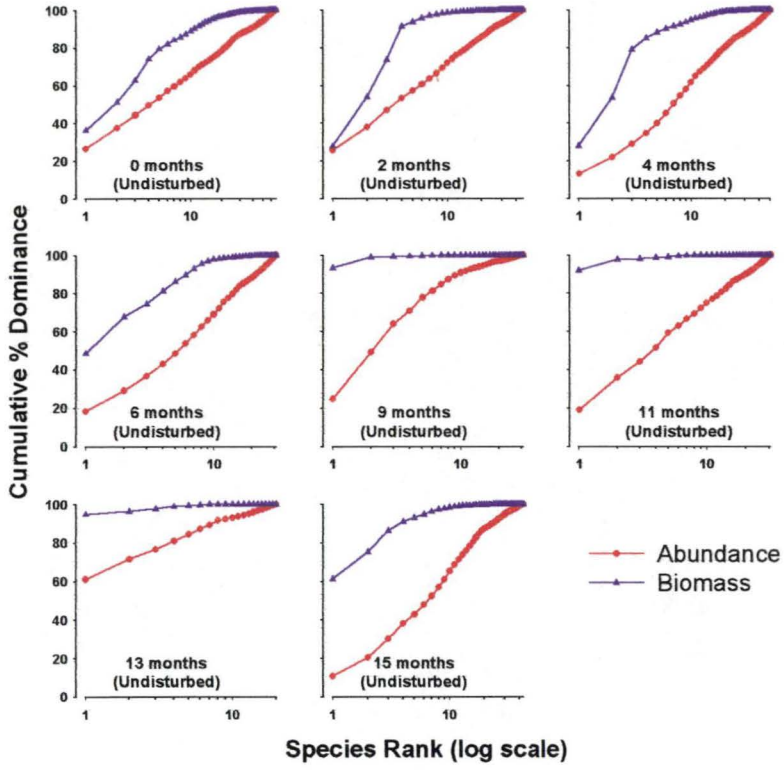


Figure 3.18 Meads Creek – ABC curves for the reference station.

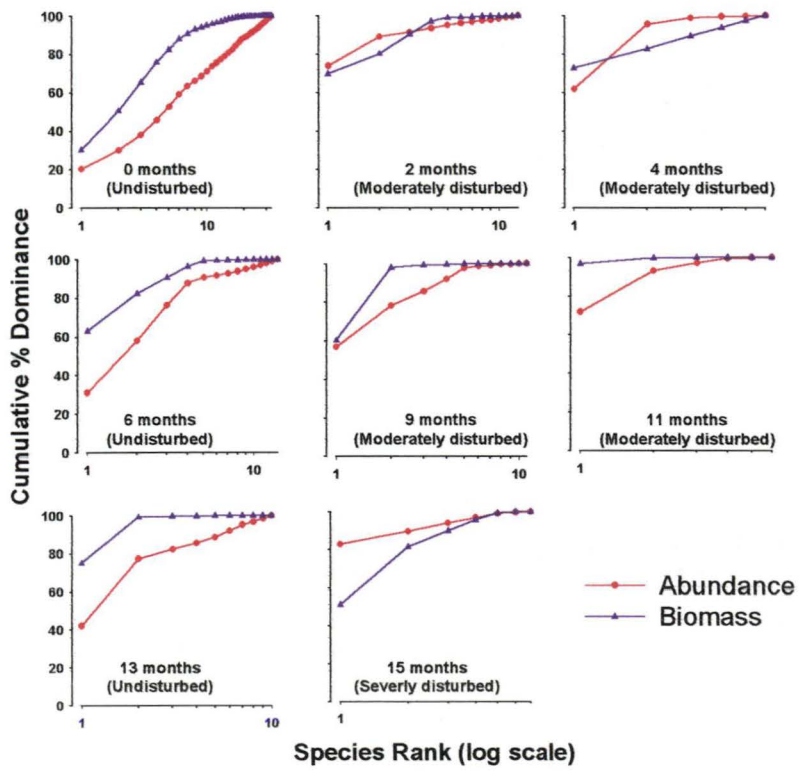


Figure 3.19 Meads Creek – ABC curves for cage 1.

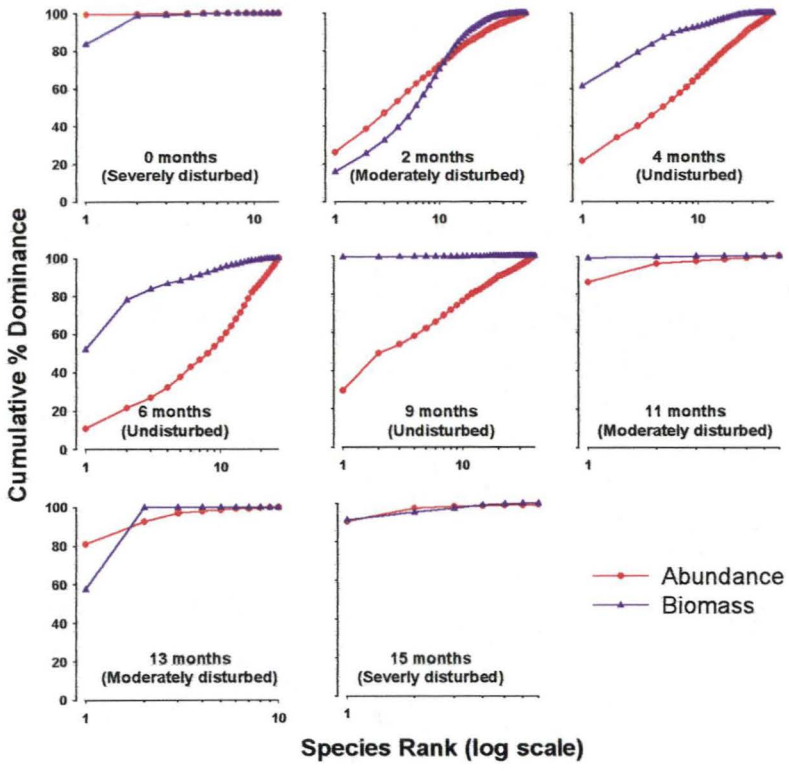


Figure 3.20 Meads Creek – ABC curves for cage 2.

3.3.4.3 Assessment of Simple Macrofaunal Measures

The number of species recorded for both the reference station and the cage stations at Meads Creek varied markedly over time (Figure 3.21). The numbers of species recorded were similar to those encountered at Nubeena. However, unlike Nubeena there was no clear evidence of a seasonal pattern in species numbers at the reference station.

ANOVA indicated that there was a highly significant interaction between station and time (Table 3.15). Post hoc testing (Appendix 3.8) showed that although there was no obvious seasonal trend in species numbers, those at the reference station did vary significantly over time. A higher number of species was recorded at the initial sample visit than at 6, 9, 11or 13 months ($p<0.05$) while the samples from the 13 month sample visit displayed a significantly lower number of species than recorded at 2 ($p<0.05$) or 15 months ($p<0.01$).

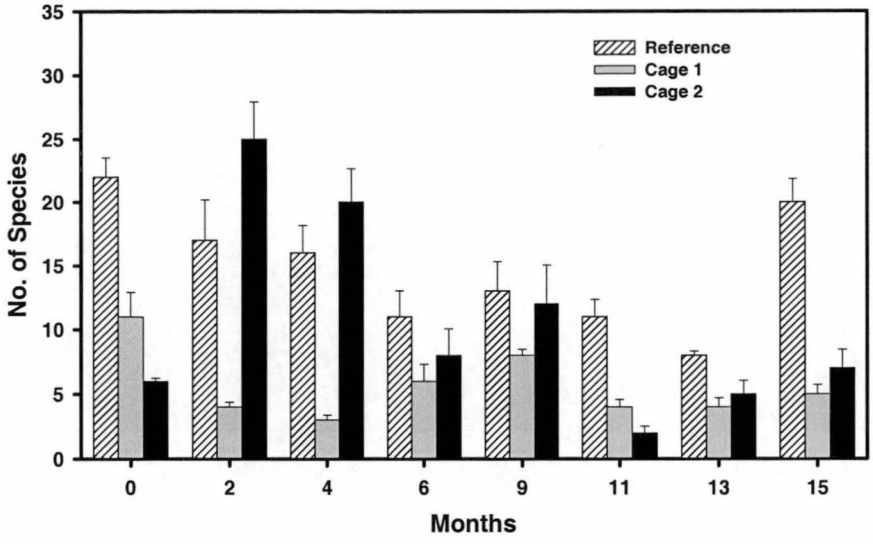


Figure 3.21 Meads Creek – Number of species (+ s.e.) for all sample stations over the temporal study.

Post hoc testing for the cage stations (Appendix 3.8) suggested that six of the cage samples had significantly reduced numbers of species relative to the corresponding reference samples (cages 1 and 2 at the 0 month sampling, cage 1 at 2 months, cage 1 at 4 months and cages 1 and 2 at 15 months). This difference suggests that these samples were all experiencing an impact. Of the six cage station samples, five were also distinguished by the multivariate assessment while the one anomalous station (cage 1 at the initial sample visit) displayed a markedly reduced diversity to the other stations but was not considered impacted in the full community assessment.

Table 3.15 ANOVA of the species richness data for the reference station, cage 1 and cage 2 at Meads Creek.

	df	MS	F-ratio	P
Time	7	192.534	13.199	<0.001
Station	2	819.073	56.151	<0.001
Time*Station	14	133.510	9.153	<0.001
Error	91	14.587		

Total abundance levels at Meads Creek were more variable than the number of species, particularly at the cage stations (Figure 3.22). On several occasions the numbers recorded from cage stations were extremely high, with levels in excess of

20,000 individuals m^{-2} occurring in one instance. The numbers recorded between replicates at the cage stations were often highly variable, as indicated by the large standard errors. Consequently, it was difficult to clearly distinguish impact. Once again there did not appear to be any clear seasonal pattern to the values recorded for the reference station although there were differences in abundance at this station over time.

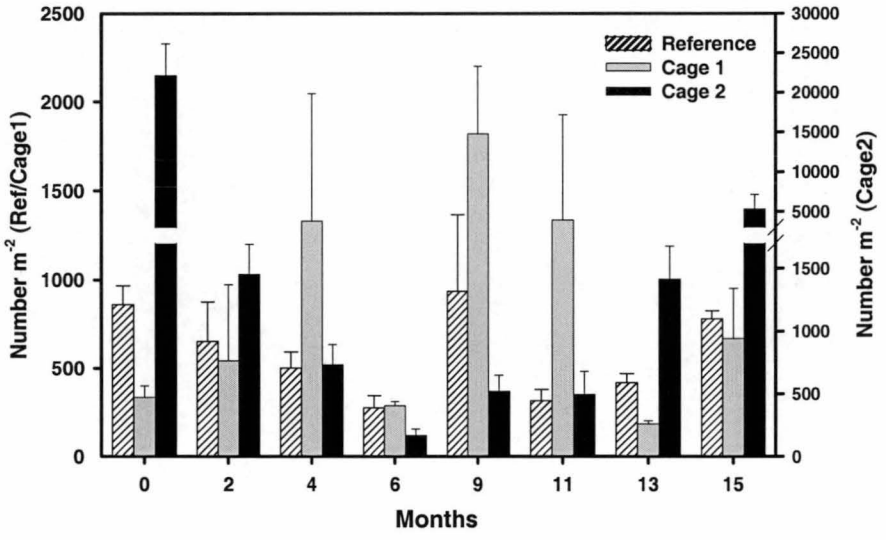


Figure 3.22 Meads Creek – Total faunal abundances (+ s.e.) for all sample stations over the temporal study.

ANOVA indicated that faunal abundance differed significantly between times and stations over the course of the study (Table 3.16). Probably as a result of the relatively high variability between the replicates pairwise comparisons (Appendix 3.9) indicated that the variation in total abundance levels at the reference station was not significant. Post hoc tests also indicated that the abundance levels at cage 1 were not significantly different from the reference conditions at any time during the study, whereas total abundance was significantly higher (an order of magnitude greater) at cage 2 than at the reference station at the first sample visit ($p<0.01$).

The pattern of abundance shown by the annelids at Meads Creek (Figure 3.23) was very similar to that reflected by the total fauna. The levels recorded from the cage stations again appeared to be very high and the differences between replicates were often great, resulting in large standard errors.

Table 3.16 ANOVA of the total faunal abundance for the reference station, cage 1 and cage 2 at Meads Creek.

	df	MS	F-ratio	P
Time	7	9.146E+07	21.831	<0.001
Station	2	1.360E+08	32.470	<0.001
Time*Station	14	9.427E+07	22.501	<0.001
Error	91	4189568.998		

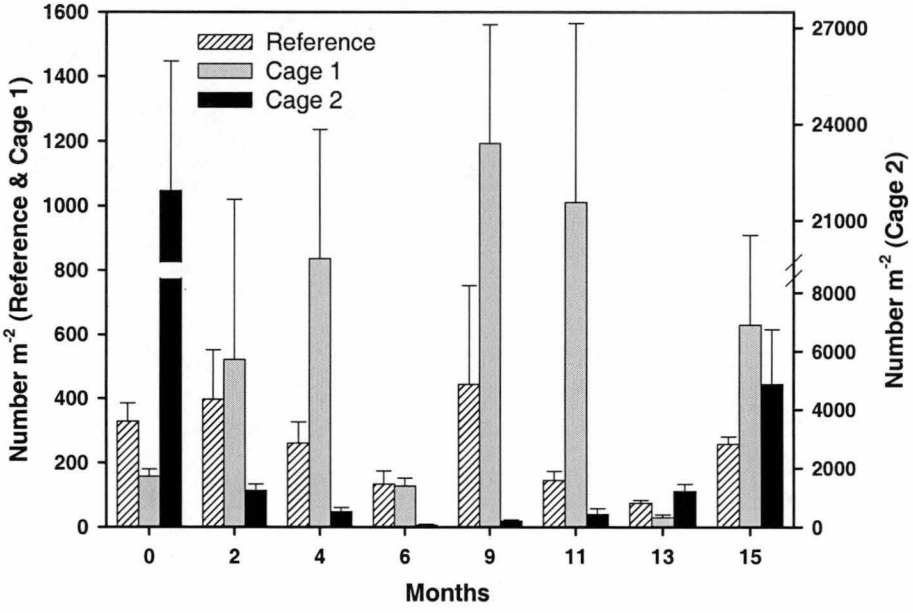


Figure 3.23 Meads Creek – Number of annelids m^{-2} (+ s.e.) for all sample stations over the temporal study.

Although ANOVA indicated a highly significant interaction between the sample time and station (Table 3.17), there was only one instance where the differences in the annelid abundance at the cage stations and corresponding reference location were significant (Appendix 3.10). Pairwise comparison (Appendix 3.10) did not show any significant differences at either the reference station or at cage 1 over time. However, as with total faunal abundance annelid abundance at cage 2 was significantly higher than the reference station at the initial sample visit ($p<0.01$).

Table 3.17 ANOVA of the annelid abundance data for the reference station, cage 1 and cage 2 at Meads Creek.

	df	MS	F-ratio	P
Time	7	8.964E+07	21.735	<0.001
Station	2	1.424E+08	34.534	<0.001
Time*Station	14	9.466E+07	22.951	<0.001
Error	91	4124257.106		

Generally the reference stations did not display large numbers of *Capitella capitata* complex. In fact *Capitella capitata* complex was only recorded from the reference stations at the initial sample visit, at 2 months and at 9 months. At the initial sample visit and at 2 months the numbers recovered were very low, (9 and 3 m^{-2} respectively). At the 9 month visit the numbers had increased to approximately 237 m^{-2}, but this was still considerably less than was encountered at the cage stations, where the overall average for cage 1 was 492 m^{-2} and for cage 2 was 3,584 m^{-2}. As has already been noted for both total abundance and annelid abundance, the numbers of *Capitella capitata* complex (Figure 3.24) displayed high between-replicate variability making it difficult to clearly distinguish differences between stations.

It is interesting to note that, if a *Capitella capitata* complex abundance of greater than 200m^{-2} were to be used as a criterion for distinguishing disturbed conditions, the following samples would be identified: the reference station at 9 months, cage 1 at 2, 4, 9 and 15 months and cage 2 at 0, 4, 11, 13 and 15 months. This combination of stations closely resembles that distinguished by the ABC method and the full community assessment.

ANOVA of *Capitella capitata* complex abundance (Table 3.18) indicated a highly significant interaction associated with time and station. However, post hoc testing showed that the levels at the reference station were insufficient to produce a significant difference between the samples over time (Appendix 3.11), whilst the only significant difference between the cage samples and the reference stations was as a result of the increased numbers recorded from cage 2 at the initial sampling ($p<0.01$).

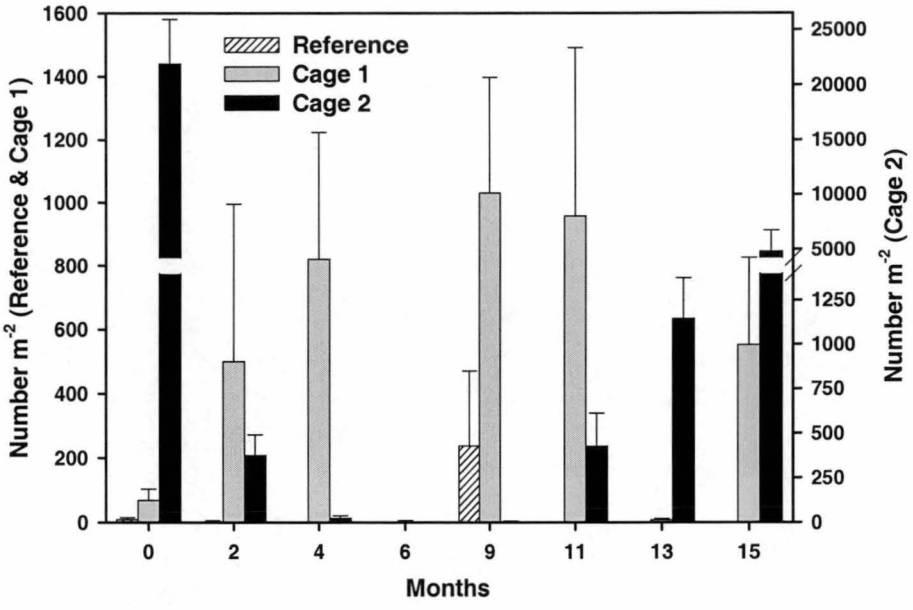


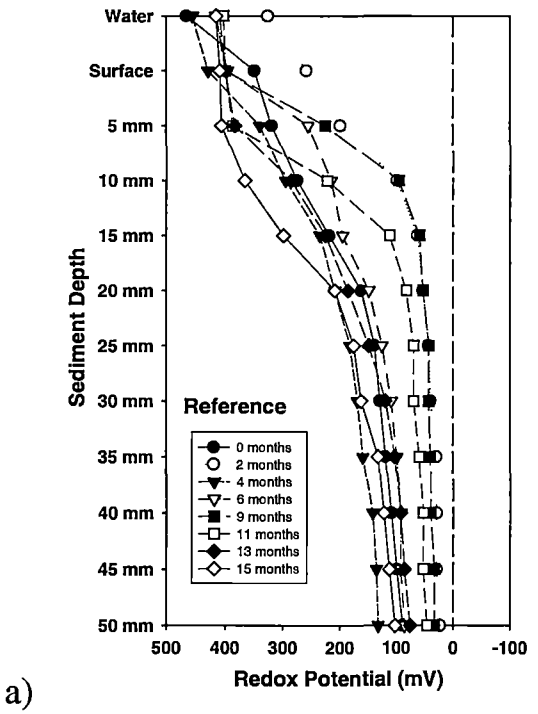
Figure 3.24 Meads Creek – Number m^{-2} *Capitella capitata* complex (+ s.e.) for all sample stations over the temporal study.

Table 3.18 ANOVA of *Capitella capitata* complex abundance data for the reference station, cage 1 and cage 2 at Meads Creek.

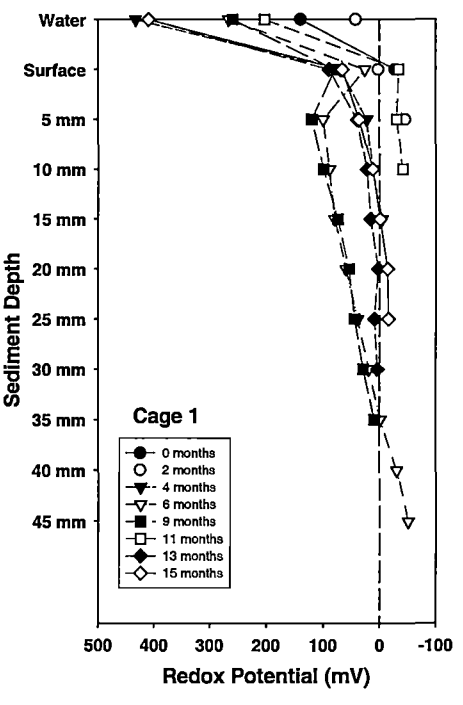
	df	MS	F-ratio	P
Time	7	8.964E+07	21.735	<0.001
Station	2	1.424E+08	34.534	<0.001
Time*Station	14	9.466E+07	22.951	<0.001
Error	91	4124257.106		

3.3.5 Redox Potential Measurement – Meads Creek

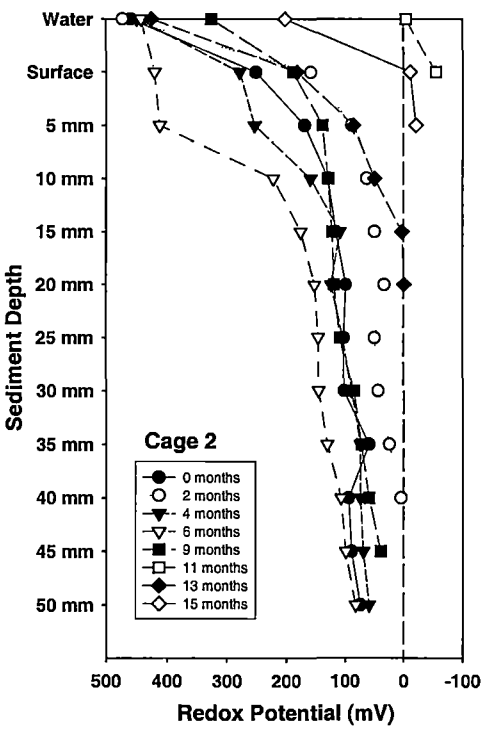
The redox profiles for Meads Creek (Figure 3.25) clearly show that all of the reference samples were aerobic to a depth of 50 mm (Figure 3.25a). In contrast, the samples for cage 1 indicate some degree of degradation (redox potentials of 0 mV at depths less than 50 mm) at all sample visits (Figure 3.25b), whilst at cage 2 (Figure 3.25c), two sample times (11 and 15 months) were associated with sediments which were anoxic at the surface and one sample (13 months) showed a reduction in the oxygen penetration depth to 20 mm.



a)



b)



c)

Figure 3.25 Redox potential profiles for Meads Creek - a) reference station, b) cage 1 and c) cage 2. Values are an average of the three replicates.

The sediment surface redox potential values recorded for the reference station were fairly constant from the 4 month sample visit but a slight reduction was observed at the 2 month sample visit (Figure 3.26). The cage stations on the other hand, showed

considerable variability over time. Cage 1 exhibited low surface redox potential and values were negative at the surface at 0 and 11 months and approached zero at the surface at 2 months. Cage 1 values were always much lower than those observed at the reference station and were generally lower than those recorded for cage 2. Cage 2 displayed positive surface redox potentials on several occasions but the sediment was anoxic at the surface at 11 and 15 months.

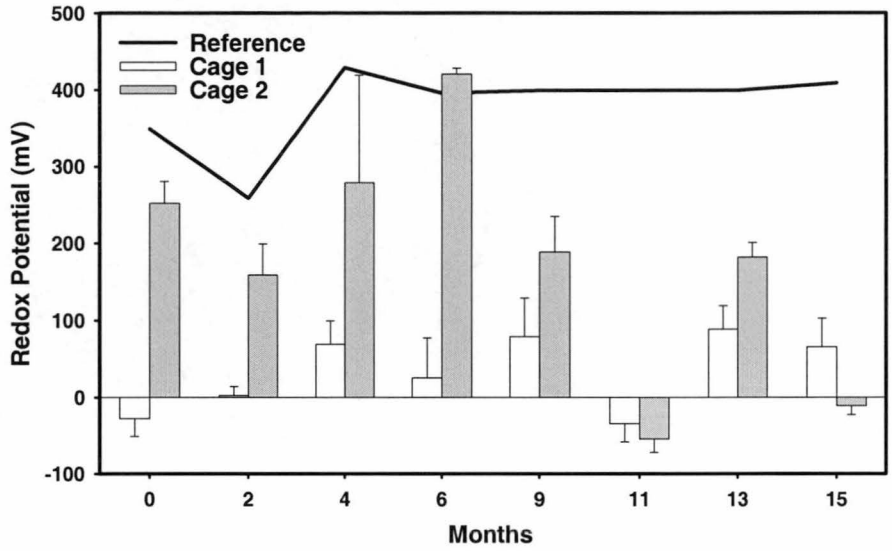


Figure 3.26 Sediment surface redox potential (+ s.e.) for all stations at Meads Creek

Two factor ANOVA (Table 3.19) for sediment surface redox potentials indicated a highly significant interaction between station and time. Pairwise comparison (Appendix 3.12) showed that there were no significant differences in the reference station results over time. Cage 1 was significantly different from the equivalent control at all times ($p<0.01$). Cage 2 was not significantly different from the equivalent reference at the first, second, third or fourth sample visits but was significantly lower at all subsequent visits (i.e. from 9 months onwards, $p<0.05$).

The RPD depths (Figure 3.27) show a very similar pattern to that observed for surface redox potential measures. The reference station measures were very consistent and in all cases, the RPD depth was greater than 50mm. At cage 1 RPD depth was markedly reduced in comparison with the reference conditions at all sample visits and the discontinuity was at the surface at the 9 month sample visit and approached the surface at both the initial sample visit and at 2 months. The

conditions at cage 2 appeared, to be somewhat better, however, the RPD was still at the surface at both 9 and 15 months.

Table 3.19 ANOVA of sediment surface redox potential for the reference station, cage 1 and cage 2 at Meads Creek.

	df	MS	F-ratio	P
Time	7	32717.605	8.575	<0.001
Station	2	726055.708	190.304	<0.001
Time*Station	14	26392.183	6.918	<0.001
Error	47	3815.248		

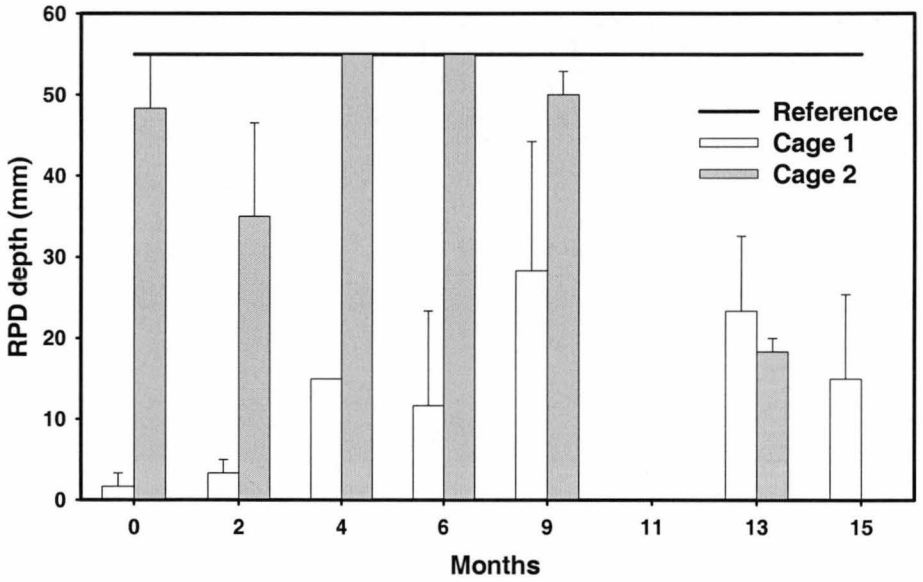


Figure 3.27 RPD depth (+ s.e.) for all stations at Meads Creek.

These differences were clearly illustrated in the results of the two-way ANOVA of RPD depth (Table 3.20) which identified a significant interaction between the station and sample times. Post hoc (Appendix 3.13) confirmed the consistency of the reference station. At cage 1 the RPD depth was found to be significantly lower than that recorded at the reference station at all sample times except at 9 months, whereas the RPD depth for cage 2 was significantly different from reference conditions at 11, 13 and 15 months ($p<0.01$), the reduction at 2 months was not found to be significant (Figure 3.27).

Table 3.20 ANOVA of RPD depth measurement for the reference station, cage 1 and cage 2 at Meads Creek.

	df	MS	F-ratio	P
Time	7	731.457	7.367	<0.001
Station	2	10950.760	110.290	<0.001
Time*Station	14	603.134	6.074	<0.001
Error	47	99.291		

3.3.6 Farm Data Assessment – Meads Creek

Farm stocking densities and feed input information were only available for cage 2 and only up until November 94. The biomass of fish held in cage 2 over the study period varied but was generally between 30 and 50 tonnes. The greatest biomass was heldover the period from December 93 until March 94, which approximately covers the period from the initial sampling until 3-4 weeks before the 4 month sample visit. The cage was fallowed for 9 weeks between March and May 94 (1-2 weeks before the 6 month sample visit). The fish when harvested recorded a mean weight of approximately 5kg. Declines in biomass over the stocking cycle (Figure 3.28) correspond to times where the fish were graded and harvest sized fish removed (i.e. mid-September 94).

Feed input over the study period varied to a much greater extent than fish biomass but overall, the input was approximately 1-2 tonnes per week. Considerably greater amounts of feed were supplied in the week beginning 17th October 94 when a total of 5.8 tonnes of feed were fed and in the week beginning 14th November 94 when 4.8 tonnes of feed was supplied.

Figure 3.29 shows the results of the multivariate analysis (dendrogram and MDS plots) of the data for cage 2 and the reference station at Meads Creek from the initial sample visit in December 93 until the 11 month sample visit in November 94. From these plots the cage samples from the initial sample visit and the 11 month visit are clearly distinguished. These two stations had been determined to be impacted in the full community assessment.

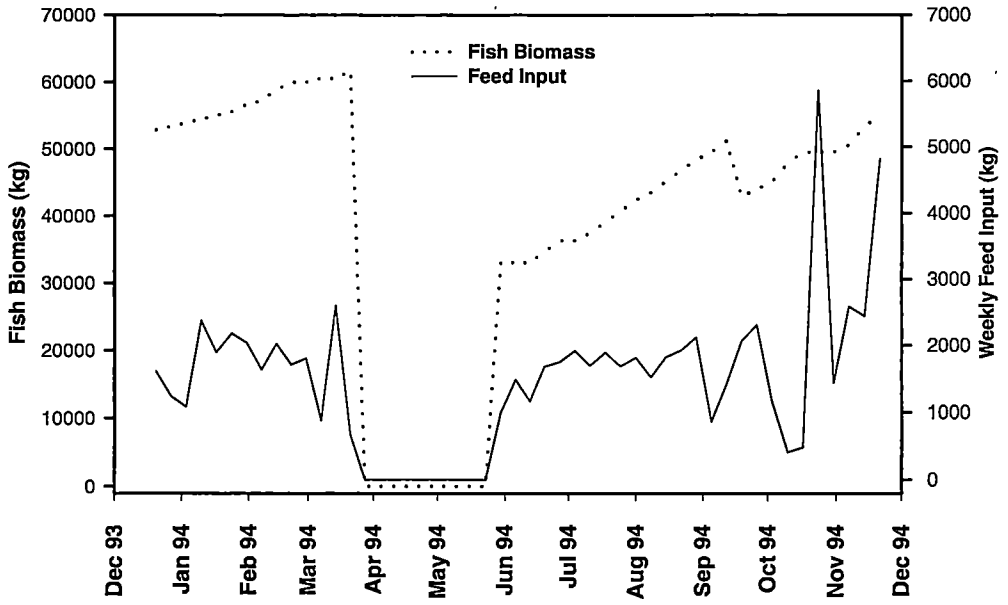


Figure 3.28 Feed input (kg) and fish stocking levels (kg) for cage 2 at Meads Creek over the duration of the temporal survey.

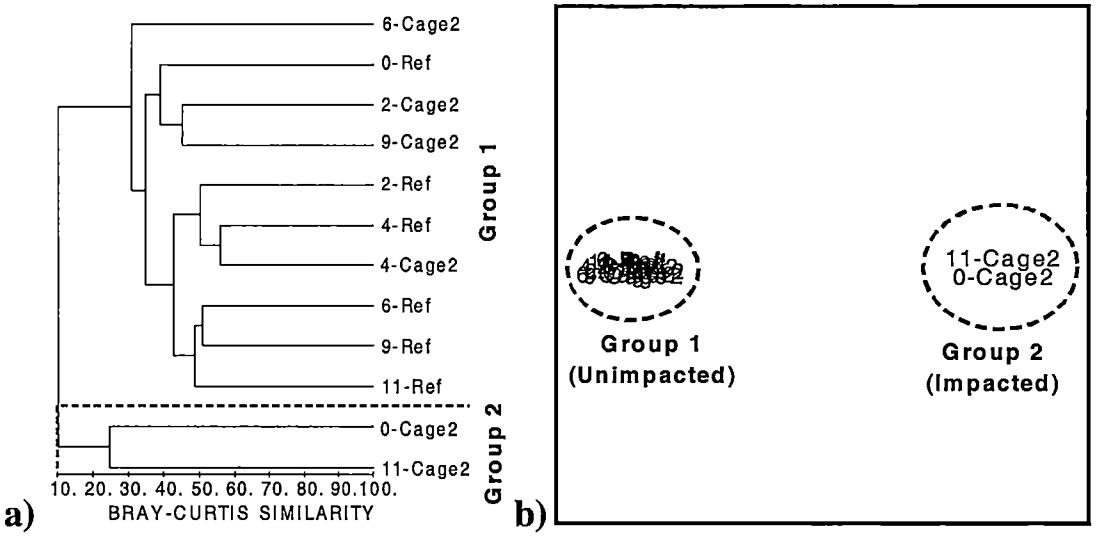


Figure 3.29 Meads Creek – a) Cluster analysis dendrogram and b) MDS ordination plot indicating impacted and unimpacted groups (Stress=0.01) for cage 2 and reference station only, from the first sample visit (0 months) until the 11 month sample visit (November 94).

When the full community assessment results are interpreted in combination with the farm information (Figure 3.30) there appears to be no clear correlation between either feed input or fish stocking level and the infaunal community distribution pattern. However, all of the samples associated with times when there was no feed

input or no fish stocked were located in group 1, i.e. unimpacted (Figure 3.30a). The sample taken during the time with the highest level of feed input (November 94, 11 month visit) was identified in group 2, i.e. impacted. The data did not indicate a strong relationship between fish stocking levels and the infaunal community structure, nonetheless all samples taken at times when there were no fish were located in group 1 (unimpacted).

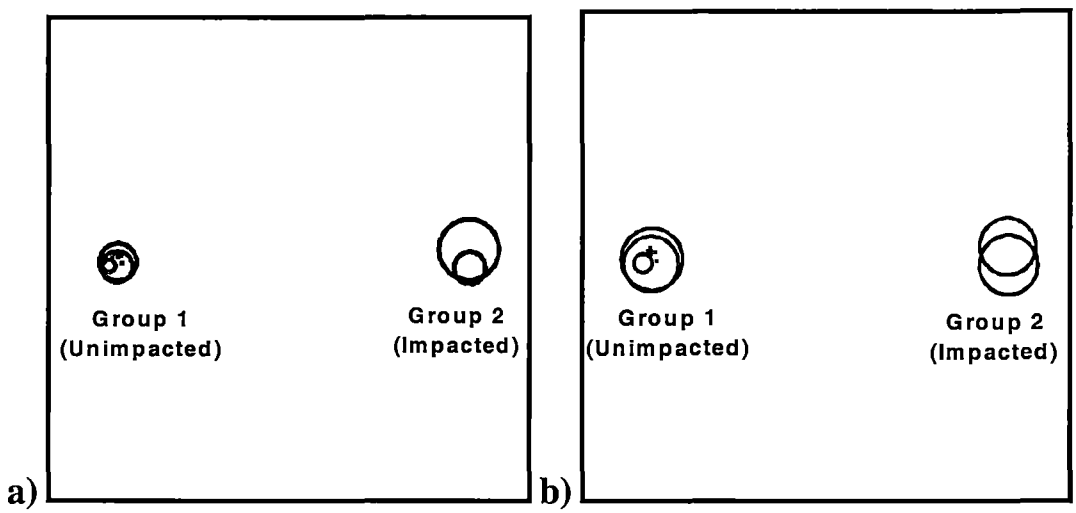


Figure 3.30 Meads Creek - MDS ordination plot (Stress=0.01) for cage 2 and reference station showing impacted and unimpacted groups until November 94 with farm data included, a) mean feed input and b) mean fish biomass over the 4 weeks prior to sampling. Circle diameter increases with increasing level.

Similarly when the redox information is superimposed on the infaunal community structure ordination plot (Figure 3.31) there was no clear relationship between redox and the community distribution. Both the surface redox measurements and RPD depths indicate that group 1 (unimpacted) samples were generally represented by large circles, indicating well oxygenated sediments (Figure 3.31 a and b). In group 2 (impacted) cage 2 at the initial visit was represented by a single point (Figure 3.31 a and b) indicating degraded conditions (anoxic at the sediment surface). However, the other sample in group 2 (cage 2 at 11 months) was represented by a mid-sized circle suggesting only mildly deteriorated conditions (Figure 3.31 a and b).

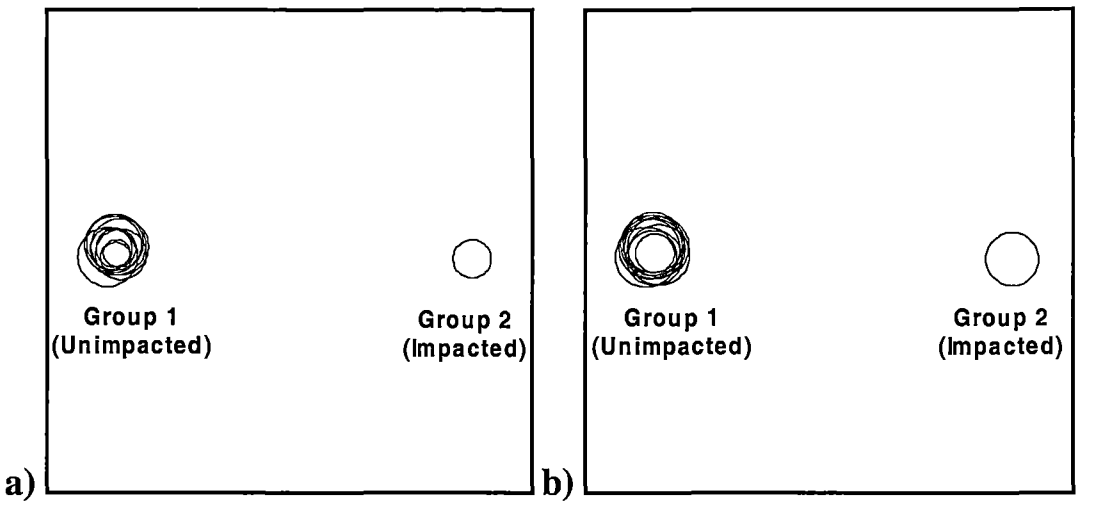


Figure 3.31 Meads Creek - MDS ordination plot (Stress=0.01) for cage 2 and reference station showing impacted and unimpacted groups until November 94 with farm data included, a) surface redox results and b) RPD depth results. Circle diameter increases with improving redox condition.

3.4 Discussion

As previously mentioned many studies have attempted to evaluate, quantify and describe the environmental impacts associated with finfish cage aquaculture. A number of studies have also compared techniques for assessment of sediment condition, although to date these have been conducted from the perspective of the environmental regulator. In contrast, there have been no studies aimed specifically at evaluating methods for use by fish farmers for farm-based assessment of environmental impact. In this context, Table 3.21 summarises the outcomes of the present study and shows how each of the techniques under evaluation categorised the samples.

3.4.1 Multivariate methods and ABC Assessment

Many studies which have shown a direct relationship between the benthic community composition and pollution or impact gradients (eg. Pearson and Rosenthal, 1978; Grizzle, 1984; Austen et al., 1989; Weston, 1990; Ferraro et al., 1991; Moore and Rodger, 1991; Agard et al., 1993). Several authors have judged multivariate analysis techniques to be the most appropriate approach to evaluation of

community structures and hence reflections of changes in those structures (e.g. Warwick and Clarke, 1991). Consequently multivariate assessment is a useful means of accurately evaluating the level of impact associated with the process of cage farming and an appropriate technique against which to judge the performance of other impact assessment parameters.

At Nubeena cluster analysis clearly divides the samples according to the extent of farm impact. Group 1, contained all of the unimpacted stations and some of the mildly impacted stations, conversely group 2, contained all of the severely impacted stations and some of the moderately impacted stations. This separation is supported by comparison of the faunal characteristics of the two groups. The unimpacted stations were not characterised by any particular species and those species that were most common tended to indicate little or no impact e.g. the selective surface deposit feeder *Pista australis* which is unlikely to occur in polluted areas (Hutchings, 2000a) as it would be inhibited in areas with large inputs of organic matter (Rhoads and Young, 1970). The two other main species present (*Mediomastus australiensis* and *Lumbrinereis* sp.) are both burrowing deposit feeders which appear to have a moderate to low tolerance of reduction in sediment oxygenation. The review of macrobenthic succession patterns by Pearson and Rosenberg (1978) lists several studies where representatives of each of these genera were commonly encountered at the edge of areas where *Capitella capitata* complex dominated. In their study on the effects of salmon farming on the benthic community Brown et al. (1987) also identified representatives from the genera *Mediomastus* and *Lumbrinereis* as amongst the dominant species in stations of intermediate impact. On the other hand the impacted stations (group 2) were very clearly dominated by *Capitella capitata* complex. This species is a well recognised, opportunistic burrowing deposit feeder which is common in areas of high organic enrichment and associated low levels of sediment oxygenation (Grassle and Grassle, 1974; Pearson and Rosenberg, 1978; Tsutsumi, 1987, 1995; Weston, 1990; Hutchings, 2000b). This is in agreement with the results of most other studies on salmonid impacts (Brown et al., 1987; Weston, 1990; Hargrave etal., 1993; Pocklington et al., 1994; Henderson and Ross, 1995) and corresponds with the results of studies on organic enrichment generally. Group 2 also had quite large numbers of the spionid polychaete, *Malacoceros tripartitus*; a relative of *Malacoceros fuliginosa* which has been associated with areas of high organic

enrichment in the northern hemisphere (Johannessen et al., 1994; Henderson and Ross, 1995).

Table 3.21 Stations categorised as significantly impacted by the various techniques (MDS, ABC method, species number, total abundance, annelid abundance, *Capitella capitata* complex abundance, redox profile, surface redox and RPD depth) at a) Nubeena and b) Meads Creek. The station reference codes in parentheses indicate distinguishable, but non-significant, changes from the reference conditions.

a. Nubeena

MDS	ABC	No. of Species	Total Abund.	Annelida Abund.	*C.capitata* cmplx Abund.	Redox profile	Surface redox	RPD depth	*Capitella* > 500m^{-2}
0-Cg1	0-Cg1		0-Cg1	0-Cg1	0-Cg1	0-Cg1		0-Cg1	0-Cg1
0-Cg2	0-Cg2	0-Cg2				0-Cg2	0-Cg2	0-Cg2	0-Cg2
2-Cg1	2-Cg1	2-Cg1		2-Cg1	2-Cg1	2-Cg1	2-Cg1	2-Cg1	2-Cg1
						2-Cg2	2-Cg2	2-Cg2	
4-Cg1	4-Cg1					4-Cg1		4-Cg1	4-Cg1
						4-Cg2	4-Cg2	4-Cg2	4-Cg2
6-Cg1	6-Cg1	6-Cg1				(6-Cg1)	6-Cg1	6-Cg1	6-Cg1
6-Cg2						6-Cg2	6-Cg2	6-Cg2	
							(11-Cg2)		
15-Cg2	15-Cg2		15-Cg2	15-Cg2	15-Cg2	(15-Cg2)	15-Cg2	15-Cg2	15-Cg2

b. Meads Creek

MDS	ABC	No. of Species	Total Abund..	Annelida Abund.	*C.capitata* cmplx Abund.	Redox profile	Surface redox	RPD depth	*Capitella* > 500m^{-2}
		0-Cg1				0-Cg1	0-Cg1	0-Cg1	
0-Cg2	0-Cg2	0-Cg2	0-Cg2	0-Cg2	0-Cg2				0-Cg2
2-Cg1	2-Cg1	2-Cg1				2-Cg1	2-Cg1	2-Cg1	2-Cg1
	2-Cg2								
4-Cg1	4-Cg1	4-Cg1				4-Cg1	4-Cg1	4-Cg1	4-Cg1
6-Cg1						6-Cg1	6-Cg1	6-Cg1	
9-Cg1	9-Cg1					9-Cg1	9-Cg1		9-Cg1
							9-Cg2		
11-Cg1	11-Cg1					11-Cg1	11-Cg1	11-Cg1	11-Cg1
11-Cg2	11-Cg2					11-Cg2	11-Cg2	11-Cg2	
13-Cg1	13-Cg1					13-Cg1	13-Cg1	13-Cg1	
13-Cg2	13-Cg2					13-Cg2	13-Cg2	13-Cg2	13-Cg2
15-Cg1	15-Cg1	15-Cg1				15-Cg1	15-Cg1	15-Cg1	15-Cg1
15-Cg2	15-Cg2	15-Cg2				15-Cg2	15-Cg2	15-Cg2	15-Cg2

The results at Nubeena also suggested that there was a seasonal component to the station separation at the reference location however, this pattern was not apparent at the cage locations. Brown et al. (1987) in their study on the effects of salmon farming in a Scottish sea loch observed seasonal fluctuations in both dissolved oxygen and in redox but found no associated changes in the macrofaunal community. Similarly, Wildish et al. (1993) looked specifically at water quality parameters around salmon farms in the Bay of Fundy and found marked seasonal differences. Where earlier studies of cage culture effects have detected seasonal changes in the benthic fauna (Holmer and Kristensen, 1992; Hargrave et al., 1993; Karakassis et al., 1998) this has usually been shown to be related to a seasonal farm production cycle rather than being a truly seasonal effect.

The primary dichotomy in cluster analysis occurred at a sample similarity level of approximately 20% at Nubeena whereas at Meads Creek, the two primary cluster groups were separated at a much lower level of similarity. This suggests that at Meads Creek the impacted and unimpacted conditions were more clearly defined, whereas at Nubeena there was a greater gradient of response to the impact. This would appear to contradict the suggestion that coastal areas are less well adapted to organic enrichment than estuarine systems (Rosenberg, 1976; Woodward et al., 1992). However, Grizzle (1984) suggested that the presence of pollution-tolerant species in an area is a function of their ability to invade and exploit a food source. Consequently, if the more estuarine system in the current study (Meads Creek) was predisposed to organic enrichment, there may already have been a reservoir of the opportunistic species *Capitella capitata* complex in the background and as a result, this species could very quickly colonise and dominate the community structure when impact occurs. On the other hand if Nubeena has no pre-disposition to organic loading there will be no such reservoir and change in the community structure will be more gradual with increasing impact. It is also noteworthy that both the impacted and unimpacted groups at Meads Creek were distinguished by the relative abundance of *Capitella capitata* complex rather than its presence/absence.

The ABC method proposed by Warwick (1986) uses the relative abundance and biomass of the fauna in a sample to identify the degree of environmental disturbance. The ABC profiles for the cage stations at Nubeena generally supported the assessment of the full community structure. The one exception was that the ABC

technique identified cage 2 at 6 months as unimpacted (Table 3.21) whilst the multivariate analysis identified this sample as impacted. However, in the multivariate ordination it is apparent that this sample was amongst those that were closest to the unimpacted group. Similarly at Meads Creek, both the ABC and multivariate methods generally indicated similarly impacted conditions (Table 3.21). However, the MDS ordination also identified samples taken from cage 1 at 6 months as impacted. Clearly, the community at this time, while broadly similar to the other unimpacted stations in overall species number, abundance and biomass, must have been quite different for the community assessment to distinguish it. The biggest difference between this sample and the other "impacted" samples was in the abundance levels of the species. Proportionally less *Capitella capitata* complex and proportionally more *Eunice bassenensis* were recorded. The ABC method also identified samples from cage 2 at the 2 month sample visit as moderately impacted when this was not indicated by the full community evaluation (Table 3.21). The samples from cage 2 at 2 months exhibited very high species diversity. Several of these species were present in quite high numbers but the most abundant species were not large individuals and consequently the abundance and biomass curves rise slowly, close together and overlap at the tail ends suggesting moderate impact. This highlights one of the weaknesses in the ABC method, as pointed out in the study by Beukema (1988), i.e. the relative positions of the k-dominance curves are strongly dependent on the position of the first ranked species. If there are no large bodied species present the first ranked species may be an abundant small bodied organism (opportunist) and the community will take on the appearance of being numbers dominated or disturbed when in fact this may not be the case. In this particular instance the full community assessment is more likely to reflect the true condition of cage 2 at this time.

Thus for the most part, the separation of sites using the ABC method appears to correspond well with that indicated by the full community assessment. The ABC method has already been evaluated under Tasmanian aquaculture conditions (Ritz et al., 1989) and in that instance proved to be a sensitive indicator of environmental impact. However, it is important to note that while the ABC method appears to give a useful and easily interpreted measure of impact, and can to some extent clarify the degree of that impact relative to full community assessment, it does not make

assessment of impact any easier from a farm management perspective. In fact, on the contrary, it requires not only enumeration of the fauna but also measurement of weights on a species by species basis. As such it is only really appropriate for validation of other techniques and, in this regard, the current study has shown that where differences were observed, the multivariate technique was usually more sensitive.

3.4.2 Evaluation of Simple Faunal Measures

Simple assessment of species richness cannot be expected to distinguish impact with the same degree of sensitivity as multivariate community assessment. Nonetheless, many studies of environmental disturbance particularly of organic enrichment have found that major impacts are reflected in large scale changes in faunal abundance. There have also been many studies of aquaculture impacts in particular which have shown that species richness declines in association with increasing organic input (eg. Brown et al, 1987; Holmer and Kristensen, 1992).

In the current study determination of the number of species identified the most impacted stations at both cage 1 and cage 2, Nubeena (Table 3.21). Whilst at Meads Creek six samples were identified as impacted, five of these were stations which had also been distinguished in the multivariate assessment (Table 3.21). Although the species richness data did not identify all of the samples determined to be impacted by the MDS and ABC methods at Nubeena, the samples that were distinguished are those on the far right (impacted) side of the ordination plot (Figure 3.3b). Similarly at Meads Creek the samples selected were amongst those most evidently impacted on the ordination plot (Figure 3.17b). The status of one station at Meads Creek was categorised differently by the multivariate and ABC assessments (cage 1 at the initial visit). This sample was not considered impacted in the full community assessment and the number of individuals recorded for each species was found to be very even. However, the inclusion of this station in the unimpacted group may be inappropriate as it also exhibited markedly reduced species richness.

The data also suggested that there was a seasonal pattern in the number of species recorded from the reference stations at Nubeena, with lower numbers being recorded over the winter and spring sample times than at the summer sample times. A similar, albeit less obvious pattern was observed at Meads Creek. Seasonal patterns were not

evident at the cage stations at either farm site. Many studies have shown evidence of changes in species composition as result of organic enrichment but it should be noted that natural fluctuations in the benthic community structure will also occur. There have been equally as many studies which have shown temporal variability in faunal composition over a variety of scales (days, months, years) (eg. Jones, 1987; Morrisey et al., 1992). These changes can be reflected in total abundance and/or species richness (Jones, 1987). Temporal differences have been attributed to a great many factors e.g. temperature and salinity changes, changes in oxygen levels, tidal fluctuations, floods, food availability, larval recruitment to name just a few. Larval availability is one factor commonly believed to strongly influence temporal patterns in species composition. As Snelgrove and Butman (1994) pointed out, larval availability itself is influenced by many factors, some of which may be influenced by seasonal events e.g. boundary-layer flow. However, although recruitment will clearly have an important influence on the seasonal patterns in the benthos it is not necessarily the dominant determinant of temporal and spatial pattern (Olafsson et al, 1994). Temporal fluctuations may occur independently of any human activity therefore it is important to allow for this is any study relating to assessment of change, by incorporating reference stations in the design of studies. Temporal fluctuations may not necessarily be spatially uniform and therefore, as recommended by Morrisey et al. (1992), it is better to employ multiple rather than single control sites, a recognised failing in the current investigation.

Total faunal abundance at the reference stations also showed a seasonal trend. However total abundance appeared to be a poorer indicator of impact at Nubeena as it only identified two samples as impacted rather than the seven identified with full community assessment and three identified with species richness (Table 3.21). Total abundance levels at Meads Creek displayed considerably more variability between replicates than was observed with species richness results, consequently there was only one sample where it was possible to distinguish an impact at a significant level. The numbers recorded for abundance will naturally be of a greater magnitude than was the case for species richness. Consequently, the between replicate variability will also be greater. This variation may be particularly evident in organically enriched areas where there may be considerable differences in the sediment conditions over very small temporal and spatial scales.

Annelid polychaetes are often amongst the most common indicators of organic enrichment and the results of the spatial survey (Chapter 2) suggested that this was the case at both of the farm sites in the current study. Temporal evaluation of the annelid abundance at Nubeena identified the same stations as impacted as were distinguished by total abundance, but with one addition, while at Meads Creek once again there was only one instance where the differences between samples were sufficiently large to determine a significant difference (Table 3.21). Consequently assessment of annelid numbers would appear to be as useful an indicator of sediment condition as evaluation of total abundance. If the measurement of abundance is limited still further to evaluation of the abundance of a single taxon, *Capitella capitata* complex, then the effort required for assessment is further reduced. *Capitella capitata* complex has long been recognised as an indicator of organic enrichment (Pearson and Rosenberg, 1978) and has been shown in many studies of the impacts of cage aquaculture to be associated with the most degraded areas (eg. Brown et al., 1987; Weston, 1990; Ye et l, 1991; Lim, 1991; Hargrave et al., 1993; Henderson and Ross, 1995; Cheshire et al., 1996). The results of the spatial survey (Chapter 2) also suggested that abundance of *Capitella capitata* complex may be a useful indicator of impact which could be readily evaluated on the farm. Over the course of the temporal survey, the pattern of the *Capitella capitata* complex abundance at Nubeena was very similar to that of the annelid and total abundances. In fact, it appears that determination of the abundance of *Capitella capitata* complex in combination with a count of the number of species, highlighted 5 of the 7 stations described as impacted by the multivariate assessment (Table 3.21). However, discrimination using this method was again less useful at Meads Creek as a result of the variability between replicates. If those stations with greater than 500 individuals of *Capitella capitata* complex m^{-2} were considered as impacted, then at both Nubeena and Meads Creek a much closer agreement with the results of the full multivariate assessment is achieved.

At both sites the total abundance data also appeared to respond to the changing pattern of fish biomass. High benthic abundances were generally associated with the times of highest fish stocking and lower abundances with times when the cages were empty or when low stocking densities were encountered. However, the samples taken from cage 2, Nubeena in April 94 represent an exception. At this time the total

benthic abundance was very high and yet the cage had only just been stocked and fish biomass was still low. Why the abundances were so elevated at this time is not clear. It may be that the level of organic enrichment was enough to enhance growing conditions, but not so much as to inhibit the macrofauna, and that these conditions, in association with the naturally increased abundances in summer/autumn favoured an increase in benthic population.

The information relating to the faunal abundance and species richness did not show a similar relationship with stocking density at Meads Creek. Here, abundances were initially high but declined markedly after the first sample visit, dropping lower still over the winter before recovering with the onset of the summer months. The high abundance occurred as a result of large numbers of *Capitella capitata* complex which indicate a response to organic enrichment. Concurrently species number showed a marked reduction at the first sample visit. Thereafter, the number of species improved suggesting a level of recovery. The large peak in abundance at the first sample visit is difficult to explain, nor is it clear why abundance subsequently declined. Similarly, there is no obvious reason for the decline in species richness and the farm records fail to provide any clues. However, as has already been suggested, one possible explanation for the faunal abundance and species richness patterns is that the benthic community rapidly adjusted to utilise the new source of organic material associated with the newly stocked cage. Opportunistic species may therefore have increased greatly in abundance to the exclusion of other species; later the community may have adjusted further with the fauna re-establishing an equilibrium at a point where it was better able to assimilate the increased organic load.

3.4.3 Evaluation of redox measures

As outlined in the general introduction (Chapter 1), measurement of sediment oxygenation is a useful means of determining sediment health and one of the most common methods is determination of redox potential. During the spatial survey (Chapter 2) evaluation of sediment redox potential, either as a profile, surface value or by determination of RPD depth, was identified as being closely related to sediment condition status based on benthic community structure. The redox profiles from cage 1 at Nubeena corresponded well with the results from the full community assessment, identifying the same impacted stations, however, the results for cage 2

were not as consistent. In this case, the redox profiles identified an additional two sets of samples (2 and 4 months) as impacted although these samples were not highlighted by the multivariate analysis (Table 3.21).

Considering the redox profiles for the Nubeena cage stations more generally, if all of the cage station profiles which differed from the comparable reference station profiles were designated as impacted, then all of the cage stations that were separated during the full multivariate species assessment would be identified. In fact, several additional samples would also be separated, suggesting that the redox profiles may provide a more conservative evaluation of sediment health than the macrofaunal assessment. Determination of redox profiles also provides an opportunity to infer the degree of impact, i.e. those stations which are anoxic at the sediment surface can be judged to be more degraded than those stations where the anoxic layer has risen within the sediment but is still well below the surface. Similar conclusions can be drawn from the redox profiles for Meads Creek where most of the samples identified as impacted by the community assessment, were also identified by comparison of redox profiles.

Similarly, measurement of surface redox potential at Nubeena also tended to reflect the differentiation of samples shown by the full community assessment, identifying the most impacted samples at each of the cage locations (Table 3.21). Furthermore, surface redox potential also indicated impact on the two additional occasions, where the macrofaunal assessment did not detect any significant effect.

For both Nubeena and Meads Creek, the measurements of RPD depth were very stable at the reference stations (rarely shallower than 50 mm and never less than 45 mm). The measurements for cage 1 at Nubeena were consistent with the sample discrimination indicated by the full macrofaunal assessment while at cage 2 the majority of impacted samples were identified (Table 3.21). Similarly, at Meads Creek, RPD data corresponded well with the full redox profiles and the results of the full community assessment, the only exceptions being those samples where marginal impacts were indicated. On the whole, assessment of RPD level is likely to be the most useful method for measurement of sediment oxygenation and results were more consistent than those provided by other variables. The differences between the RPD measurements and the full macrofaunal community assessment suggest that, in many instances, RPD may be a conservative indicator of impact. Although it was not easy

to distinguish levels of impact using RPD it is likely that, with time and experience, farm managers could develop an understanding for the level of effect associated with particular RPD depths on their farms.

At Meads Creek, the RPD depth appeared to respond more slowly to stocking changes than at Nubeena. This may be a function of this site's tendency towards hypoxia/anoxia (low in oxygen/devoid of oxygen) as finer sediments, such as those at Meads Creek, often tend to be less well oxygenated (Barnes and Hughes, 1989). The lowest RPD levels were recorded between 4 and 7 months after stocking, however it took up to 16 weeks for the RPD depth to reflect a marked deterioration. Recovery of the sediment redox potential also appeared to be quite rapid at Meads Creek as the RPD depth recovered to a level comparable with control conditions within 6 weeks of the fish being removed.

When comparing surface redox potential and RPD depth values in relation to the ordination plots associated with the benthic infaunal community structure, it is apparent that those samples with a deep RPD tend to be associated with the unimpacted cluster. Furthermore, surface redox was less consistent than the RPD depth, therefore it is suggested that RPD depth measurement may be a more reliable indicator of environmental degradation.

3.4.4 Incorporation and Evaluation of Farm Production Data

To date, only two studies have attempted to evaluate techniques for assessment of sediment health (Cochrane and Pearson, 1995; Codling et al., 1995) and in both cases the focus was on assessment for regulatory purposes. There have been no studies which have focussed on farm based assessment or which have attempted to integrate evaluation of benthic sediment condition and cage management information. This study uses cage specific feed and stocking information to describe the relationship between cage management practices and benthic condition.

The multivariate assessment of community structure indicated a gradient of impact at Nubeena, however there were a number of stations which appeared at the centre of the MDS plots and differentiation of these samples on the basis of faunal composition and/or RPD depth was problematic. For example, two of the five stations which were determined to be severely impacted on the basis of the RPD depth results at Nubeena were clustered within group 1 (Cage 2 at 2 and 4 months).

The farm data suggest that these stations may have been in the process of becoming degraded. At 4 months the site records indicate that the cages had only recently been restocked after having been empty for a period of 5 weeks. As a result, it is possible that the fauna may have recovered sufficiently during this fallow period for the community structure to start to resemble that at an unimpacted location. In addition, following restocking the initial fish biomass was low and therefore the associated feed input was relatively low, consequently it is possible that at this level of impact the sediment may have been able to assimilate the organic material. Later however, as the fish biomass increased, and the associated feed input increased, the input of organic material may have begun to accumulate on the seabed. Such deposition can rapidly exceed the faunal and bacterial community's ability to decompose organic matter (Raa and Liltved, 1991) which in turn would result in reduced sediment oxygen levels (Braaten, 1991; Raa and Liltved, 1991). As the benthic community may take longer than redox levels to respond to these changed conditions, it is possible that the redox and community data at the 4 month visit reflected these differing response rates. At the 11 month sample visit each of the replicate redox cores produced very different results. This sample visit occurred approximately 3 weeks after the cage location had been fallowed following six weeks of heavy stocking and therefore it is likely that both the sediment redox potential and the faunal community were in the process of recovery. Faunal recolonisation and rehabilitation is not a uniform process, larval settlement and recolonisation can be patchy and as a consequence some areas may recover more quickly than others (Morrisey et al., 1992; Warwick, 1993). Moreover, small scale differences in the spatial pattern of recovery are likely to have the most influence on smaller sample sizes (Hurlbert, 1984). This may explain the large variation observed in the redox profiles of the three replicates at 11 months. In contrast, the larger size of the benthic infaunal samples would make them less susceptible to such small scale patchiness and should therefore provide a more uniform and reliable representation of the sediment status. Indeed, the benthic infauna replicates taken at this time were more consistent and showed the fauna to be relatively undisturbed.

The concurrent variation in macrofaunal community parameters (total abundance and number of species), sediment oxygenation (represented by RPD depth) and farm production status (indicated by fish biomass and feed input) provides evidence of

possible causal relationships. Although there was no direct correlation between the fish biomass data and any of the physical / chemical parameters, some relationship may be inferred. For example, assuming that the RPD response were to lag behind the accumulation of fish biomass, then the RPD depth does indeed appear to worsen in response to increased fish biomass. In this regard, the extent of the time lag would appear to be related to the direction of change in these parameters (i.e. degradation or recovery phase). Thus changes in the RPD appear to occur more quickly in response to increasing stocking density and therefore increasing impact than to reducing stocking density and decreasing impact. The results for Nubeena suggest a time lag in response to increasing impact in the order of 3 months and a figure closer to 6 months in response to the removal of fish. Here, the limitations of such conclusions must be acknowledged as farm data were only available for one of the cages studied.

Comparison of feed input data and the macrofaunal community structure at Nubeena suggests that low feed levels tended to be associated with the unimpacted stations and that the impacted stations were generally associated with larger feed inputs. Exceptions to this pattern tended to reflect anomalies in the feed data: for example, one cage was harvested prior to the sampling visit and it is to be expected that the fish would have been starved prior to harvest. However, this was not indicated in the feed data. In contrast at Meads Creek feed input data could not be related to benthic community structure (as indicated by the ordination plot) or to sediment physical / chemical parameters (surface redox or RPD depth).

Combining the fish biomass details with the MDS plot for Nubeena revealed three instances where a very large biomass of fish corresponded with impacted samples. Each of these instances related to stations where fish had been stocked in the cages for greater than 2 months. There were also three instances where large biomasses of fish were associated with unimpacted samples/stations. In one instance, a storm event may have removed much of the accumulated organic material and facilitated a level of sediment recovery. In another as a result of recent stocking of the cage, the community structure appeared to have deteriorated. In the third, samples were taken just after the fish were harvested and as it is unlikely that the sediment would have had sufficient time to recover, some other factor must have affected the benthic community structure.

In summary, fish biomass data did not correlate well with benthic community structure. Certainly the presence of fish in cages was not in itself sufficient to provide any indication of the level of environmental impact. Generally, where irregularities existed in the classification of sediment condition, benthic faunal assessment provided the most accurate indicator of impact. However, possible explanations for any differences could be developed with access to farm data and the farm manger's local knowledge of weather and lease conditions. Therefore, it is suggested that neither farm data nor redox measures alone are sufficient to provide a good understanding of the sediment conditions associated with cages. Farm data should be considered in combination with other parameters such as redox and knowledge of local conditions affecting the lease.

3.4.5 Conclusions and Recommendations

In order to fully evaluate the usefulness of simple techniques for assessment of sediment condition it was first necessary to obtain a reliable evaluation of sediment condition. Full assessment of the macrofaunal community structure through multivariate analysis as well as the abundance-biomass comparison method clearly identified significant differences in the levels of impact associated with cage farming operations. The results of these analyses indicated that the two study sites differed markedly in the faunal response to impact but that at both sites, impact was detectable and quantifiable. Different species were indicative of the reference or background conditions at each site whereas the principal species indicative of impact at either site was the opportunistic polychaete *Capitella capitata* complex. The results suggested that natural temporal variations in the faunal composition occurred mainly in relation to abundance and diversity. It was also clearly demonstrated that the sediment and benthic community associated with the farm cages could recover to levels comparable to reference conditions when left without fish for extended periods of time. Due to the length of the sampling interval it was not possible to exactly establish the time required for recovery. However, the results suggest that recovery may have been quite rapid in some circumstances. At Nubeena, recovery was recorded within 7 and 14 weeks, a result which is remarkably similar to that described by Ritz et al. (1989). The shorter of these two periods appears to have been assisted by the scouring effects of local storms. At Meads Creek one sample visit where recovery was evident occurred six weeks after the removal of fish. This is

markedly more rapid than the 185 days (approximately 26 weeks) estimated by Woodward et al (1992) from their work on sediment respiration at another site in the same area.

The main aim of this study was to assess several faunal, physical and chemical variables with the aim of identifying those which would be most useful as farm-based techniques for evaluation of sediment condition. The faunal variables evaluated were species richness and three measurements of abundance: total benthic abundance, annelid abundance and *Capitella capitata* complex abundance. The major finding of this study was that none of the faunal measurements distinguish exactly the same samples as the full community assessment. However, some measurements were clearly better than others. For example, number of species differentiated between 43-45% of the samples identified as impacted in the full assessment. The success of the different techniques in identifying impact varied between the two study sites and the majority were generally less successful at Meads Creek than at Nubeena. This was largely due to the fact that the assessment was based on establishing a significant difference between the samples and appropriate reference conditions. In this regard there was substantial between replicate variability for each parameter at Meads Creek and establishment of significance was therefore more difficult. It may be argued that farm-based assessments only require to identify impacted and unimpacted conditions on the farm and that evaluation of reference conditions is not a worthwhile use of resources. However, it should be remembered that unless reference conditions are assessed, it will not be possible to distinguish with certainty whether the cause of disturbance is a farm effect or some other external factor. With this in mind, the results of the current study indicated that a threshold abundance of *Capitella capitata* complex could be employed to provide a meaningful distinction between samples. Taking *Capitella capitata* complex abundance of 500 m^{-2} as the cut off level, this criterion identified 86% of the impacted samples at Nubeena and 73% of the samples at Meads Creek.

The spatial study (Chapter 2) identified that some measurement of sediment redox potential was likely to be the most appropriate physical / chemical indicator of sediment condition. The results of the temporal study support this conclusion and indicate that evaluation of the sediment redox profile generally resulted in an accurate reflection of sediment condition, identifying more than 90% of the samples

distinguished in the full community assessment. However, measurement of the full redox profile is quite time consuming and some skill is required to conduct the procedure properly. Measurement of the surface redox was certainly easier but the results indicated that this approach was less reliable. In general, the surface sediments were susceptible to disturbance both in situ and in the sample cores. Consequently measurement of the RPD depth would appear to be the most appropriate means of evaluating sediment oxygenation. The level of discrimination achieved with RPD depth matched that obtained using the redox profiles. In this investigation all of the measurements of redox potential indicated impact in some samples where the macrofaunal community did not. In each case, when the results were assessed in conjunction with the farm data it appeared as though the sediment conditions were in decline and that the benthic macrofauna had not yet responded to the change in conditions. In view of this it is suggested that redox (RPD depth) should be measured on the farm on a regular basis (fortnightly/monthly) and that 2-3 consecutive positive results should be required to provide a reliable indication of recovery.

In this context, it was found that sediments with RPD depths of 50mm or greater were associated with unimpacted fauna and that when the RPD depth approached the surface (<5mm) the community structure was noticeably impacted. Consequently three categories are recommended for farm based evaluation: unimpacted (RPD depth >50mm), moderately impacted (RPD depth between 50-10mm) and severely impacted (RPD depth <10mm).

It is important to note that the above recommendations are only intended to provide a guide for farm mangers to assist them in planning their farm activities. The parameters outlined are not able to provide absolute guarantees of sediment health and it is important they are monitored regularly and validated at regular intervals using faunal assessments. This is particularly important when initiating any monitoring programme. Furthermore, it is important to evaluate these recommendations on farms other than those included in the present study.

Chapter 4 –
The Level of Taxonomic Discrimination Required For Farm-Based Assessment of Sediment Condition.

4.1 Introduction

As outlined in Chapter 1, the primary aim of the present study was to identify a simple technique for farm-based assessment of sediment health. However, at the outset of the project it was clear that one possible outcome could be our inability to identify such a technique. Consequently, it was decided that an alternative way in which this study could possibly assist help farm managers would be to provide an evaluation of the data with regard to the level of taxonomic discrimination required to assess sediment condition.

Full species level assessment of the community structure is generally regarded as the most sensitive measure of the benthic condition. However, full species level benthic community assessment is both time consuming and requires a high level of taxonomic expertise making benthic assessments very expensive.

If the status of the stations in this study could be described by simpler methods, such as using a higher taxonomic level or particular faunal groups, resource requirements (eg. time, expertise) would be reduced which in turn would reduce the costs and make assessments a more viable option for farm managers.

The issue of taxonomic sufficiency relates to the concept that organisms must be identified to a level (species, genera, family, etc) which balances the need to indicate their biology (including such matters as diversity) with the need for accuracy in making identifications (Ellis, 1985). In this regard, James et al. (1995) go so far as to suggest that there is no value in species level identification if the species are not described or if their ecology is unknown (as would be the case with a large proportion of the Australian marine fauna).

In this regard, Rosenberg (1972, 1973, 1976) documented changes in the proportions of echinoderms, crustaceans, molluscs and polychaetes in a Swedish estuary with the commissioning and closure of a sulphide pulp mill. Echinoderms only occurred in

later seral stages following closure of the mill, and were absent from the pollution tolerant "pioneer community", which developed after commissioning of the mill and which was dominated by polychaetes. Warwick (1988c) cited the work of Dauvin (1984) who showed that the subtle effects of the Amoco Cadiz oil spill on the Bay of Morlaix could still be detected at the level of major taxa (Amphipoda). There have also been several other studies which suggest that pollution effects influence the community structure at a level higher than species (Pearson and Rosenberg, 1978; Warwick, 1988b, 1988c; Ferraro and Cole, 1990, 1992; James et al. 1995).

This chapter compares species level assessment with the following approaches to assessment of benthic community structure.

1) Assessment of the full benthic community at higher taxonomic levels (family, order, class, phylum).

2) Species level evaluation of restricted faunal groups - echinoderms, crustaceans, molluscs and polychaetes.

3) Assessment of phylum Annelida at species, family and order level.

Finally, the results of these assessments are evaluated with respect to farm management requirements.

4.2 Materials and Methods

Samples were obtained and processed as described in chapter 2.

4.2.1 Statistical Analysis

The community structure and patterns of station distribution associated with different faunal groups and varying taxonomic levels were analysed using several statistical analysis techniques contained within the Plymouth Routines In Multivariate Ecological Research (PRIMER) statistical analysis package.

The distribution of the stations at each site was evaluated using cluster and ordination techniques. Cluster analysis aims to identify "natural groupings" of samples such that samples within a group are more similar to each other than samples in different groupings (Clarke and Warwick, 1994). In this case the clustering technique used was a hierarchial agglomerative method with group-average linking using a starting

matrix developed from Bray-Curtis similarity measures for each station with replicates combined.

The ordination technique employed in this study was non-metric Multi-Dimensional Scaling (MDS). This technique also uses the matrix of Bray-Curtis similarity measures. MDS constructs a map or configuration of samples, in a specified number of dimensions, which attempts to satisfy all the conditions imposed by the rank similarity matrix (Clarke and Warwick, 1994). The analysis is an iterative process; the MDS plot is constructed many times until it displays the position of the sample stations in a manner which most closely satisfies the dissimilarity relations between them. The stress level associated with each plot is a measure of the goodness of fit of the plot as displayed, in either 2- or 3-dimensional space, to the real multidimensional distribution of the samples. Warwick and Clarke, (1994) give some useful guidelines on interpreting MDS plot stress levels. They suggest that a stress level < 0.05 can bc considered to be an excellent representation of the real distribution; a stress level <0.1 indicates a good ordination with little likelihood of misleading information; a stress level <0.2 is still potentially useful, however for values in the upper end of this range it is not wise to rely too heavily on the detail and finally they suggest that a stress level >0.3 indicates that the points are close to being arbitrarily placed in the 2-dimensional ordination space.

Cluster and ordination analyses were used in combination to assess the multivariate community structure information for each taxonomic level and faunal group at the two sites. The results of these techniques were compared and contrasted with the results from the full species level community assessment.

The resultant similarity matrices for the differing taxonomic levels and faunal groups were compared using another PRIMER analysis technique, RELATE. RELATE analysis was conducted on the matrices of Bray-Curtis similarity measures for the differing taxonomic levels and faunal groups at each of the two sites. This technique compares the similarity matrices using their rankings rather than the actual matrix values to test the null hypothesis (H_0) - there is no relationship between the two matrices. The ranks were compared using the harmonic Spearman rank correlation coefficient (p), where p lies within the range (-1,1). A value of –1 would indicate that the two sets of ranks are in complete opposition, whilst a value of 1 would apply

when ranks are in complete agreement (however p=1 would never occur due to the manner in which the similarity matrix is constructed).

Finally the faunal composition was examined using an analysis technique called SIMPER to identify and compare the components of the faunal community which define the ordination groups. SIMPER is a program which examines the species similarity matrix and highlights the species or, in the case of the analyses at higher taxonomic level, the taxa principally responsible for determining the sample grouping in the cluster and ordination analyses (Clarke and Warwick, 1994). The results of the SIMPER analyses were compared for the two sites and the differing taxonomic levels and faunal groups.

4.3 Results

4.3.1 Assessment of the benthic community at higher taxonomic levels (family, order, class, phylum).

The first dichotomy in cluster analysis of the data from Nubeena clearly distinguished seven stations (0-Cage 1, 0–Cage 2, 2-Cage 1, 4-Cage 1, 6-Cage 1, 6 – Cage 2 and 15 – Cage 2) – group 2, (Figure 4.1 a, b). Assessment of the species composition of this group by SIMPER analysis (Table 4.1) indicated that it was dominated by *Capitella capitata* complex. This species was highly abundant, averaging around 3000 individuals per station. Generally, the stations within this group were species poor with less than ten species recorded per station. SIMPER analysis also showed that within this group 30% of the within-group similarity could be attributed to the above species complex.

SIMPER analysis (Table 4.1) showed the first group identified by cluster analysis (Figure 4.1) to be primarily characterised by two species; a terebellid polychaete, *Pista australis*, which accounted for about 8% of the within-group similarity and another capitellid polychaete, *Mediomastus australiensis*, which accounted for 7% of the overall group similarity. There was greater species diversity associated with the stations comprising group 1 than those in group 2, but the group 2 stations displayed higher species abundances.

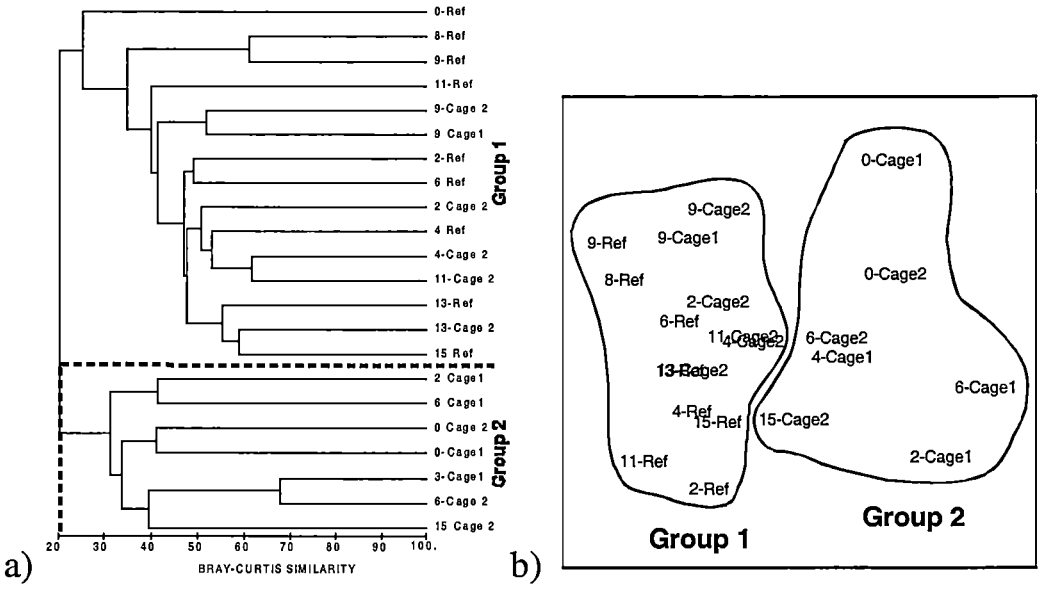


Figure 4.1 Multivariate analysis of abundance data for reference and cage stations at Nubeena (over all sample times, replicates combined, data √√ root transformed) conducted on data identified to species level.
a) Dendrogram using group-average clustering from Bray-Curtis similarities.
b) 2-dimensional MDS configuration of the 22 stations. Cluster groups reflecting the primary dichotomy at a similarity level of 20% are shown outlined (Stress=0.12).

Table 4.1 SIMPER output indicating a) and b) group average similarity and average abundance, ratio (average similarity/ st.dev. similarity) and % similarity of the five most important species in each of the main groups at Nubeena.

a) Group 1 – All stations other than those listed below.
Group Average Similarity – 34.93

Species	Average Abundance	Ratio	% Similarity
Pista australis	131.09	4.08	7.90
Mediomastus australiensis	153.43	2.03	6.72
Lumbrinereis sp.1	25.51	2.20	5.21
Capitellidae sp.2	26.34	2.12	5.21
Amphiura elandiformis	21.23	2.11	5.14

b) Group 2 - (0-Cage1, 0–Cage2, 2-Cage1, 4-Cage1, 6-Cage1, 6–Cage2 and 15–Cage2).
Group Average Similarity – 43.31

Species	Average Abundance	Ratio	% Similarity
Capitella capitata complex	3260.74	2.53	30.55
Malacoceros tripartitus	158.20	3.19	15.10
Neanthes cricognatha	118.41	1.25	9.85
Leptochelia dubia	24.34	0.90	5.79
Echinocardium cordatum	35.56	0.89	4.23

At species level there were seven stations which formed group 2 – 0-Cage 1, 0–Cage 2, 2-Cage 1, 4-Cage 1, 6-Cage 1, 6–Cage 2 and 15–Cage 2. Increasing the taxonomic resolution to family level (Figure 4.2a) produced an immediate loss of discrimination relative to species level assessment, in that stations 4-Cage 1, 6-Cage 2 and 15-Cage 2 were lost from group 2. In the MDS plot of the species ordination (Figure 4.1b) these were the stations which appeared closest to the group 1 (unimpacted) cluster. The first division in the cluster analysis at family level occurred at an overall group

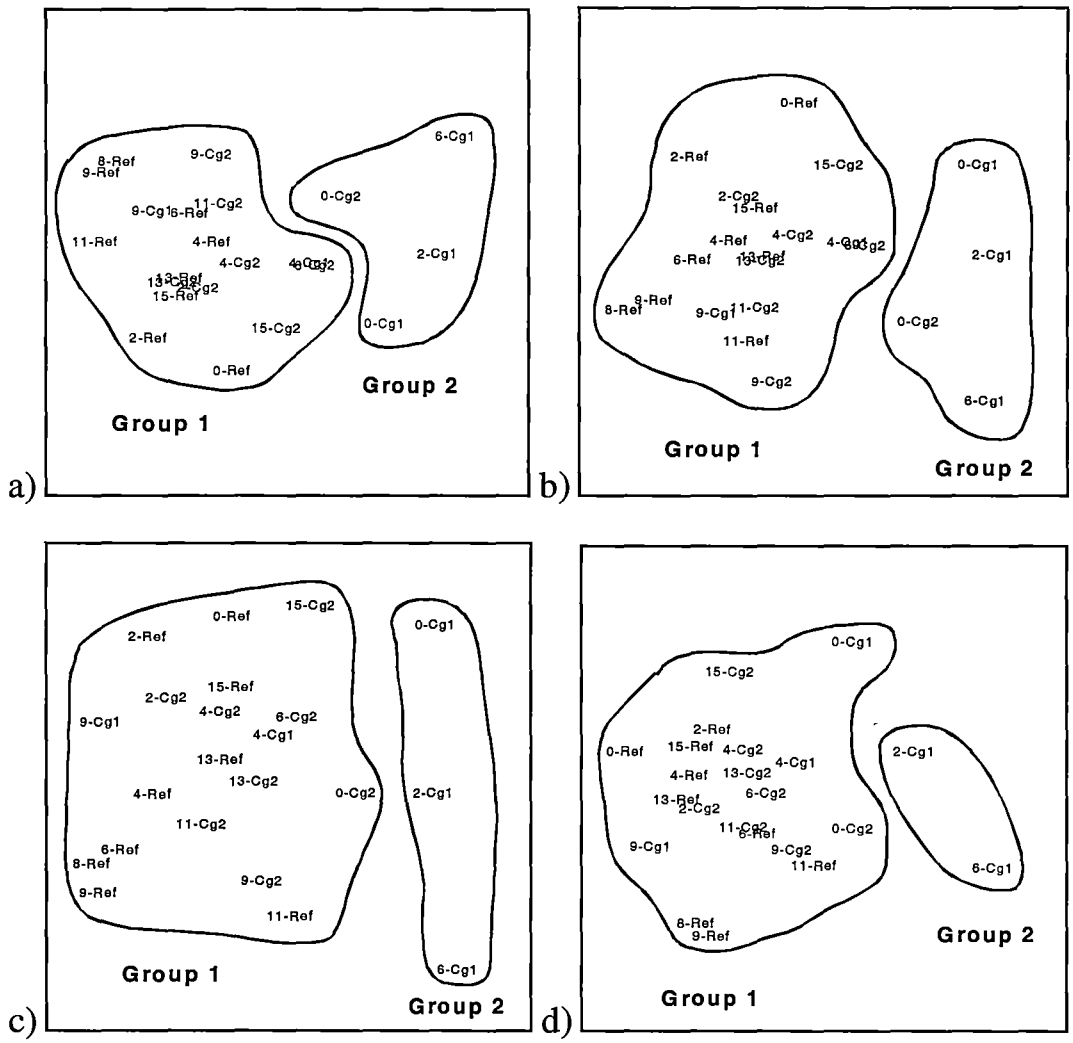


Figure 4.2 Two-dimensional MDS configurations of community identifications conducted at a) family (stress = 0.13), b) order (stress = 0.14), c) class (stress = 0.14) and d) phylum level (stress = 0.11) for stations at Nubeena (over all sample times, replicates combined, data $\sqrt{\sqrt{}}$ root transformed). Groupings identified by the primary dichotomy in group-average clustering from Bray-Curtis similarities are shown outlined.

similarity level of 27%, slightly higher than with species level identification (20%). Family level analysis still distinguished those group 2 stations which were considered to have been most impacted in the full assessment.

The same stations were again identified at order level (Figure 4.2b) while the primary dichotomy occurred at an overall group similarity of 44%. Increasing the taxonomic resolution to class level (Figure 4.2c) resulted in the loss of a further station (0-Cage 2) and an increase in the overall similarity at separation to 52%. At phylum level (Figure 4.2d) only two stations could be distinguished (2-Cage 1 and 6-Cage 1). These two stations separated from the remaining group at a similarity level of 60%.

Separation of the stations at each increasing taxonomic level tended to correspond with the increasing dichotomous separations of group 2 at the species level of identification (Figure 4.1a). The first dichotomy within group 2 distinguished stations 2-Cage 1 and 6-Cage 1 – the most impacted stations and those identified at phylum level. The next dichotomy separated stations 0-Cage 2 and 0-Cage 1 from stations 4-Cage 1 and 6-Cage 1 – i.e. those stations distinguished at family/order level.

RELATE analysis (Table 4.2) indicated a strong relationship between the species level identification matrix and all of the matrices from higher taxonomic levels. The harmonic Spearman rank correlation coefficient was highest for the species/family comparison and declined with increasing taxonomic level, suggesting that, though the matrices were strongly related, there was a better relationship between matrices at the lower taxonomic levels.

Table 4.2 RELATE analysis results, Nubeena. Comparison of higher taxonomic groups with species level identification.

Taxonomic Level	Global RHO	Significance
Family	0.944	<0.0001
Order	0.884	<0.001
Class	0.702	<0.001
Phylum	0.704	<0.001

At each change in taxonomic level there was a reduction of approximately 50% in the number of taxa. At species level 232 taxa were identified whereas at phylum

level, it was necessary to identify only 13 taxa (Table 4.3). The percentage of single species represented at each taxonomic level also varied markedly, with the greatest reduction occurring at family level. However, between 46% of the taxa observed at family level and 39% of the taxa observed at order level were represented by single species (largely equivalent to species level discrimination). There were fewer single species taxa at order level. However, single species continued to represent 23% of the taxa observed at phylum level.

Table 4.3 Total number and relative percentages recorded from Nubeena for each major taxonomic classification in relation to species level identification.

	Species	Family	Order	Class	Phylum
No. of taxa	232	117	51	24	13
% Relative to Species Identification		50%	22%	10%	6%
% of Single Species Taxa		46%	39%	29%	23%

This relatively high proportion of single species still represented at phylum level may explain why the cluster analysis and MDS representations for phylum level identification still resemble so closely the species level separation.

The first dichotomy in the cluster analysis of the data from Meads Creek distinguished two groups at a similarity level of 14% (Figure 4.3a) with group 1 containing all of the samples from the reference stations.

Examination of the species composition of the groups using SIMPER analysis (Table 4.4) indicated that group 1 contained a large number of species (40.6 ± 3.91 s.e.) relative to group 2 (10.4 ± 1.07 s.e.). The invertebrate communities of the group 1 stations were not dominated by any particular species or group of species. However, stations from this group tended to be characterised by the presence of the brittle star *Amphiura elandiformis*, nemertean worms, and the capitellid polychaete *Mediomastus australiensis* (Table 4.4). Although each of these species contributed only a small proportion of the overall sample similarity, together they accounted for approximately 21% of the group similarity.

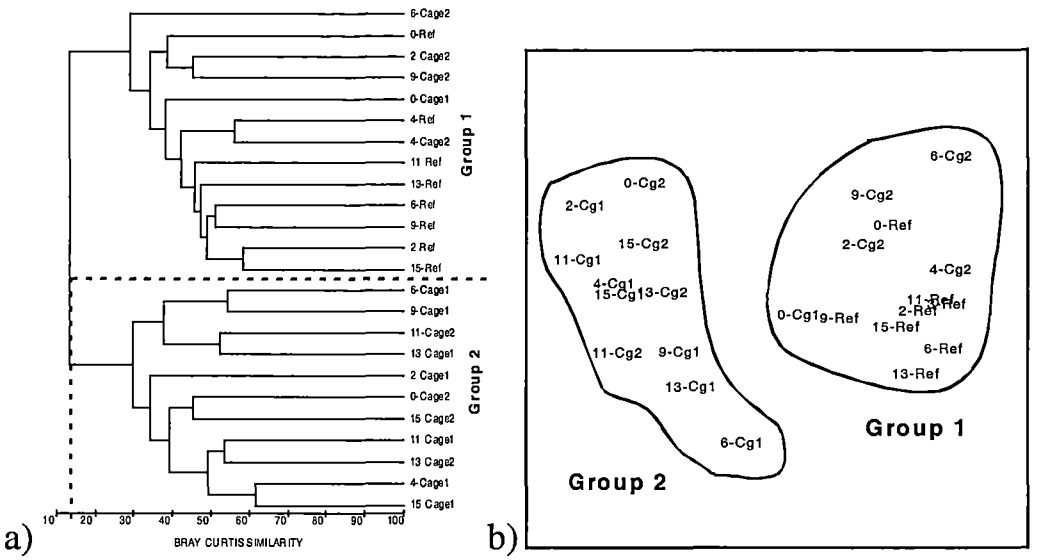


Figure 4.3 Multivariate analysis of abundance data for reference and cage stations at Meads Creek (over all sample times, replicates combined, data $\sqrt{\sqrt{}}$ root transformed) conducted on data identified to species level.
a) Dendrogram using group-average clustering from Bray-Curtis similarities.
b) 2-dimensional MDS configuration of the 24 stations. Cluster groups reflecting the primary dichotomy at a similarity level of 14% are shown outlined (Stress=0.12).

Conversely group 2 stations were dominated by the opportunistic polychaete *Capitella capitata* complex which accounted for 42% of the overall group similarity (Table 4.4). *Capitella capitata* complex was consistently observed at stations within group 2 at an average abundance level of approximately 900 individuals per station. The relatively high abundance of this species complex and the low numbers of other species recorded from stations within group 2 would tend to imply environmental disturbance. However, on occasions, this species/complex was even more abundant at stations within group 1 (>1500 individuals m^{-2}).

At Meads Creek increasing the taxonomic resolution to family level did not change the pattern of discrimination (Figure 4.4a). Those stations separated at species level were also separated at family level. At family level the primary dichotomy from cluster analysis occurred at an overall group similarity level of 22%. This pattern of site separation was maintained at order level (Figure 4.4b), with the first division occurring at an overall group similarity level of 35%. At class level (Figure 4.4c) the ability to discriminate between the groups was affected, with four stations (6-Cage 1, 9-Cage 1, 13-Cage 1 and 15-Cage 1) changing status relative to the primary

separation. However, these stations could still be discerned at the second level dichotomy (not shown) where three of the four stations (6-Cage 1, 9-Cage 1 and 13-Cage 1) formed a sub-group of group 2.

Table 4.4 SIMPER output indicating a) and b) group average similarity and average abundance, ratio (average similarity/ st.dev. similarity) and % similarity of the five most important species in each of the main groups at Meads Creek.

a) Group 1 - stations and times not identified in group 2.
Group Average Similarity – 36.81

Species	Average Abundance	Ratio	% Similarity
Amphiura elandiformis	44.39	1.69	7.88
Nemertea sp.	17.55	2.00	6.61
Mediomastus australiensis	41.71	1.78	6.25
Lysilla jennacubinae	20.23	1.43	5.65
Lumbrinereis sp.	19.03	1.45	5.36

b) Group 2 – Cage 2 at 0, 11, 13 & 15 months; Cage 1 at 2, 4, 6, 9, 11, 13 & 15 months.

Group Average Similarity – 36.20

Species	Average Abundance	Ratio	% Similarity
Capitella capitata complex	928.33	1.73	42.14
Maoricolpus roseus	42.49	0.67	10.05
Nemertea sp.	12.53	0.92	9.51
Eunice bassensis	9.05	0.94	9.28
Neanthes cricognatha	10.21	0.70	6.52

At phylum level station 15-Cage 1 returned to group 1 (Figure 4.4d) and the ordination of stations was similar to that obtained at species level separation with the exception of only three stations (6-Cage 1, 9-Cage 1 and 13-Cage 1). Stations 9-Cage 1 and 13-Cage 1 could be easily distinguished within group 1 in the subsequent dichotomy. However, station 6-Cage 1 was not readily distinguishable from the remaining stations within group 1.

In contrast to Nubeena, at Meads Creek there did not appear to be a relationship between the stations identified in the primary dichotomies at increasing taxonomic level and their associated level of impact.

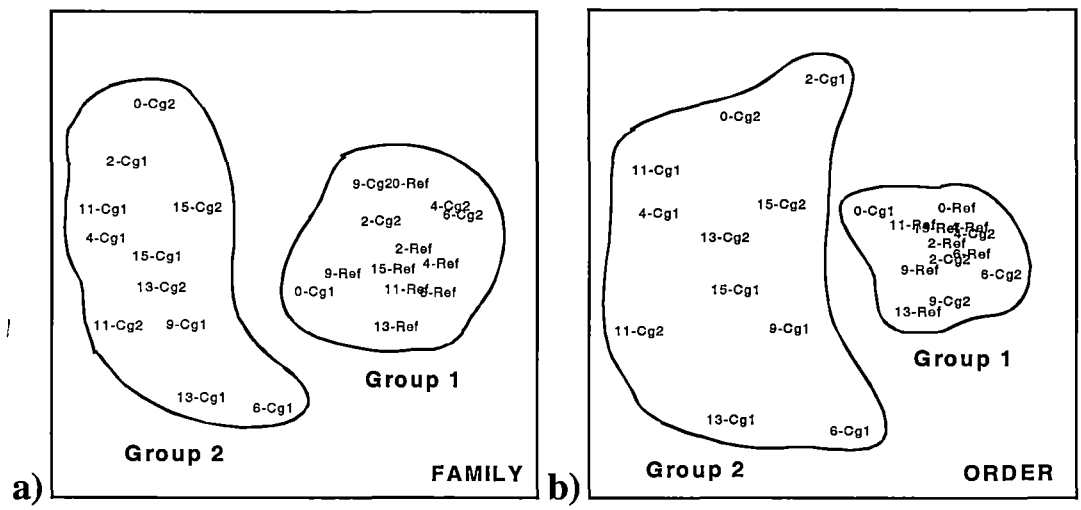
RELATE analysis indicated a strong relationship between the species level identification matrix at Meads Creek and the matrices from all the higher taxonomic levels (Table 4.5). The harmonic Spearman rank correlation coefficient was highest in the species-family comparison and declined with increasing taxonomic level. This

suggests that, though the matrices were all strongly related, there was a better relationship between matrices at the lower taxonomic levels.

Table 4.5 RELATE analysis results, Meads Creek. Comparison of higher taxonomic groups with species level identification.

Taxonomic Level	Global RHO	Significance
Family	0.938	<0.001
Order	0.803	<0.001
Class	0.699	<0.001
Phylum	0.567	<0.001

At Meads Creek, as at Nubeena, there was a large decline in the number of identifications required with increasing taxonomic level (185 at species level compared with 10 at phylum level; Table 4.6). There was a greater proportion of single species taxa at each taxonomic level at Meads Creek relative to Nubeena (Tables 4.3 and 4.6). At family level 56% of taxa were represented by a single species, whereas at order level this declined to 42%, and at class level and phylum level only 38% and 30%, respectively, were single species (Table 4.6).



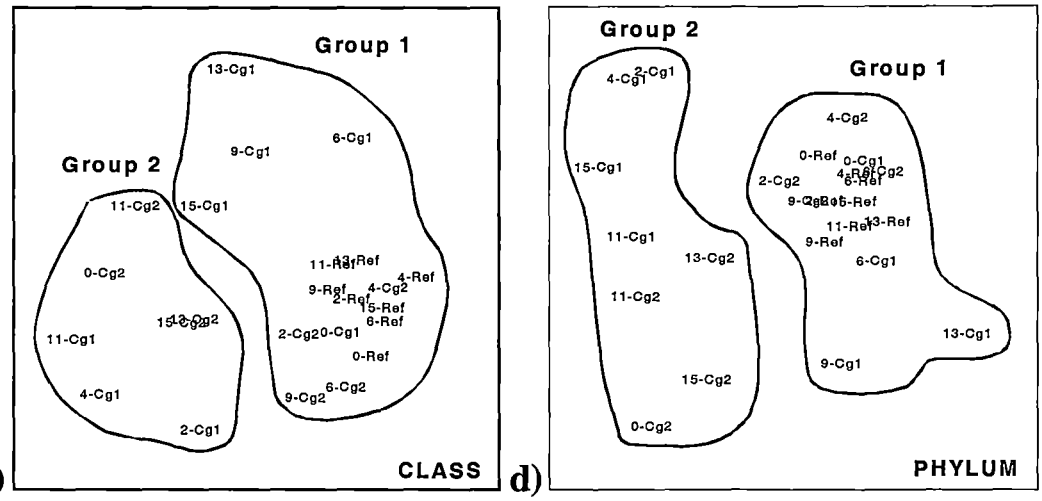


Figure 4.4 Two-dimensional MDS configurations of community identifications conducted at a) family (stress = 0.14), b) order (stress = 0.14), c) class (stress = 0.18) and d) phylum level (stress = 0.15) for stations at Meads Creek (over all sample times, replicates combined, data $\sqrt{\sqrt{}}$ root transformed). Groupings identified by the primary dichotomy in group-average clustering from Bray-Curtis similarities are shown outlined.

Table 4.6 Total number and relative percentages recorded from Meads Creek for each major taxonomic classification in relation to species level identification.

	Species	Family	Order	Class	Phylum
No. of taxa	185	101	45	21	10
% Relative to Species Identification		55%	24%	11%	5%
% of Single Species Taxa		56%	42%	38%	30%

4.3.2 Species level evaluation of restricted faunal groups - echinoderms, crustaceans, molluscs and polychaetes.

A total of 10 species of echinoderm were identified from Nubeena. Stations 2-Cage 1 and 6-Cage 1 (described in the temporal survey as most impacted) had no echinoderms present. The two main groups identified by cluster analysis (Figure 4.5 a, b) tended to correspond with those distinguished by the species level assessment of the full community structure (Figure 4.1) and RELATE analysis (Table 4.7) indicated that there was a significant relationship between the full community species matrix and that of the echinoderms alone.

Group 2 (Figure 4.5 a, b) contained most of the stations identified as impacted in the full assessment. All the stations within this group were represented by a single echinoderm species, *Echinocardium cordatum*. Group 2 also contained a single station (0-Ref) which was not considered impacted in the full assessment. This station was the reference station from the spatial survey and was included within group 2 because the only echinoderm recorded was *Echinocardium cordatum*. The two stations considered most impacted in the full assessment (2-Cage 1 and 6-Cage 1) had no echinoderm fauna.

Table 4.7 RELATE analysis results, Nubeena. Comparison of major faunal groups with species level identification.

Taxonomic Level	Global RHO	Significance
Echinodermata	0.444	<0.001
Crustacea	0.781	<0.001
Mollusca	0.418	<0.001
Annelida	0.863	<0.001

Group 1 (Figure 4.5 a, b) contained all the reference stations and most of the stations identified as unimpacted in the full assessment. Stations within this group contained a range of echinoderm species and were generally characterised by the brittle star, *Amphiura elandiformis*, which accounted for 50% of the within group similarity (Table 4.8).

Table 4.8 SIMPER output indicating a) and b) group average similarity and average abundance, ratio (average similarity/ st.dev. similarity) and % similarity of the most important echinoderm species in each of the main groups at Nubeena. No echinoderms were recorded from cage 1 at 2 or 6 months.

a) Group 1 – Cage 1 at 4 and 9 months; Cage 2 at 4, 9, 11 and 13 months; Reference station at 2, 4, 6, 8, 9, 11, 13 and 15 months. Group Average Similarity – 76.06

Species	Average Abundance	Ratio	% Similarity
Amphiura elandiformis	14.14	3.38	50.38
Echinocardium cordatum	17.23	1.21	31.79
Holothuroidea sp.3	6.65	0.84	16.09
Ophiuroid sp.	1.19	0.17	0.94

b) Group 2 – Cage 2 at 0, 6 and 15 months; Cage 1 at 0 months; Reference station at 0 months. Single species recorded. Group Average Similarity – 61.29

Species	Average Abundance	Ratio	% Similarity
Echinocardium cordatum	41.33	-	-

One station (4-Cage 1) which was considered impacted in the fulassessment, also appeared in this group. This station had low overall abundance of echinoderms with three species *Amphiura elandiformis*, *Echinocardium cordatum* and a Holothurian (Holothuroidea sp.3) represented in equal numbers.

At Nubeena 85 species of Crustacea were identified. The primary dichotomy separated only two stations (6-Cage 1 and 2-Cage 1) from the main group (group 1; Figure 4.6). Again, these stations were the ones described as the most impacted stations in the temporal survey (chapter 3). Reduced species richness was a characteristic of these two stations. The phoxocephalid amphipods, *Birubius cartoo* and *Brolgus tattersalli* were common at all the other stations (group 2) but were absent at these two stations whereas larger numbers of both *Leptochelia dubia* and *Nebalia* sp. were encountered at these stations than were found at the group 2 stations (SIMPER analysis – Table 4.9).

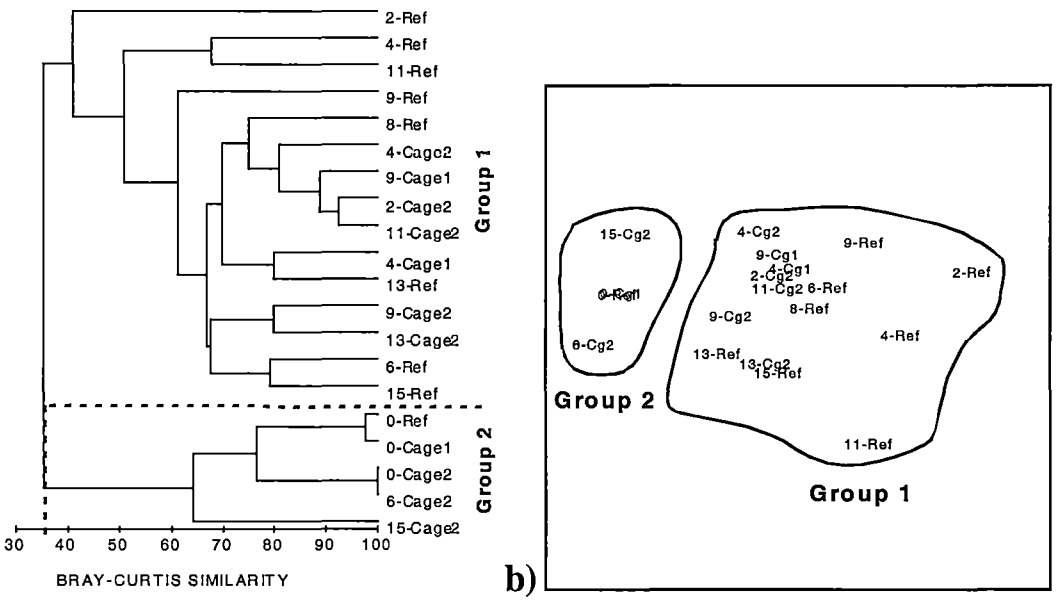


Figure 4.5 Species level identification of Phylum Echinodermata from Nubeena. (reference and cage stations, replicates combined, over all sample times, data √√ root transformed) conducted on data identified to species level.

a) Dendrogram using group-average clustering from Bray-Curtis similarities

b) 2-dimensional MDS configuration of the 22 stations; cluster groups indicative of the primary dichotomy at a similarity level of 35% are shown outlined (Stress=0.12).

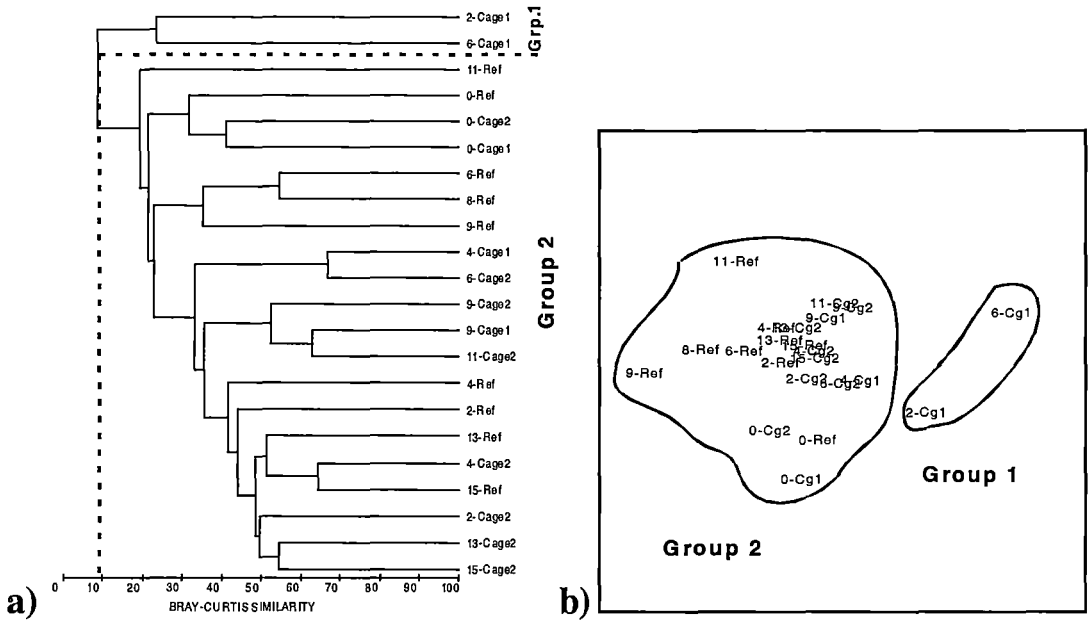


Figure 4.6 Species level identification of Phylum Arthropoda (Crustacea) from Nubeena. (reference and cage stations, replicates combined, over all sample times, data √√ root transformed) conducted on data identified to species level.

a) Dendrogram using group-average clustering from Bray-Curtis similarities

b) 2-dimensional MDS configuration of the 22 stations; cluster groups indicative of the primary dichotomy at a similarity level of 9% are shown outlined (Stress=0.16).

The group 2 stations did not appear to display any clear pattern in their subsequent separations. The stations which had been identified as impacted in the full assessment were not distinguishable as a sub-group within group 2. Stations 0-Cage 2 and 0-Cage 1 clustered together, as did stations 4-Cage 1 and 6-Cage 2, possibly reflecting the comparable levels of impact previously described at these stations. However, stations 0-Cage 2 and 0-Cage 1 also associated with station 0-Ref suggesting time of sampling as a factor determining separation. Group 2 stations appeared to separate as a result of small changes in species number and identity rather than large changes in the community structure. The stress level associated with the MDS plot (Figure 4.6b) for Crustacea was higher (0.16) than for previous plots, indicating that the 2-dimensional representation of station positions was not as reliable as it had been for the other faunal groups.

Table 4.9 SIMPER output indicating average abundance (groups 1 and 2), ratio (average dissimilarity/ st.dev. dissimilarity) and % between group dissimilarity of the most important crustacean species for the two main groups at Nubeena.

a) **Group 1** – Cage 1 at 2 and 6 months.
Group 2 – All stations and times not identified in group 1.
Average Dissimilarity Between Groups– 91.28

Species	Group1 - Average Abundance	Group2 - Average Abundance	Ratio	% Dissimilarity
Birubius cartoo	0.00	20.31	1.73	5.37
Eusiridae sp.1	2.96	0.19	2.00	4.37
Brolgus tattersalli	0.00	19.27	1.24	4.33
Lyssianassidae sp.	23.70	8.05	1.17	4.07
Jassa sp.	0.00	10.44	1.21	4.05

A total of 20 species of mollusc were identified at Nubeena and on that basis two stations were clearly distinct from all others (Figure 4.7a). The reference station at the 6 month sample visit was the first station to be separated from the main group at an overall similarity level of only 1%. This station might be considered as an outlier as the molluscan community at this station was represented by a single individual of a chiton species which was recorded from only a single replicate and which was not identified elsewhere in this study. Cage 1 at the 2 month sample visit also appeared to be somewhat anomalous. In this instance, a single opisthobranch was recovered from one replicate. However, this species was also recorded from one other station in the study.

Four stations were excluded from the analysis, as no molluscs were identified; three were reference stations (4-Ref, 8-Ref and 9-Ref) and one (6-Cage 1) was considered to be impacted by the full species assessment. The remaining stations separated into two main groups, (groups 3 and 4, Figures 4.7 a, c). There appeared to be no relationship between the distribution of stations within these groups and the levels of impact as determined by the full species assessment. Rather, the stations appeared to be separated in relation to the time of sampling. Group 3 comprised the samples from the first two sampling visits whilst group 4 contained the later samplings. This pattern was extended with the division of the group 4 stations into 4a and 4b (Figure 4.7 a, c).

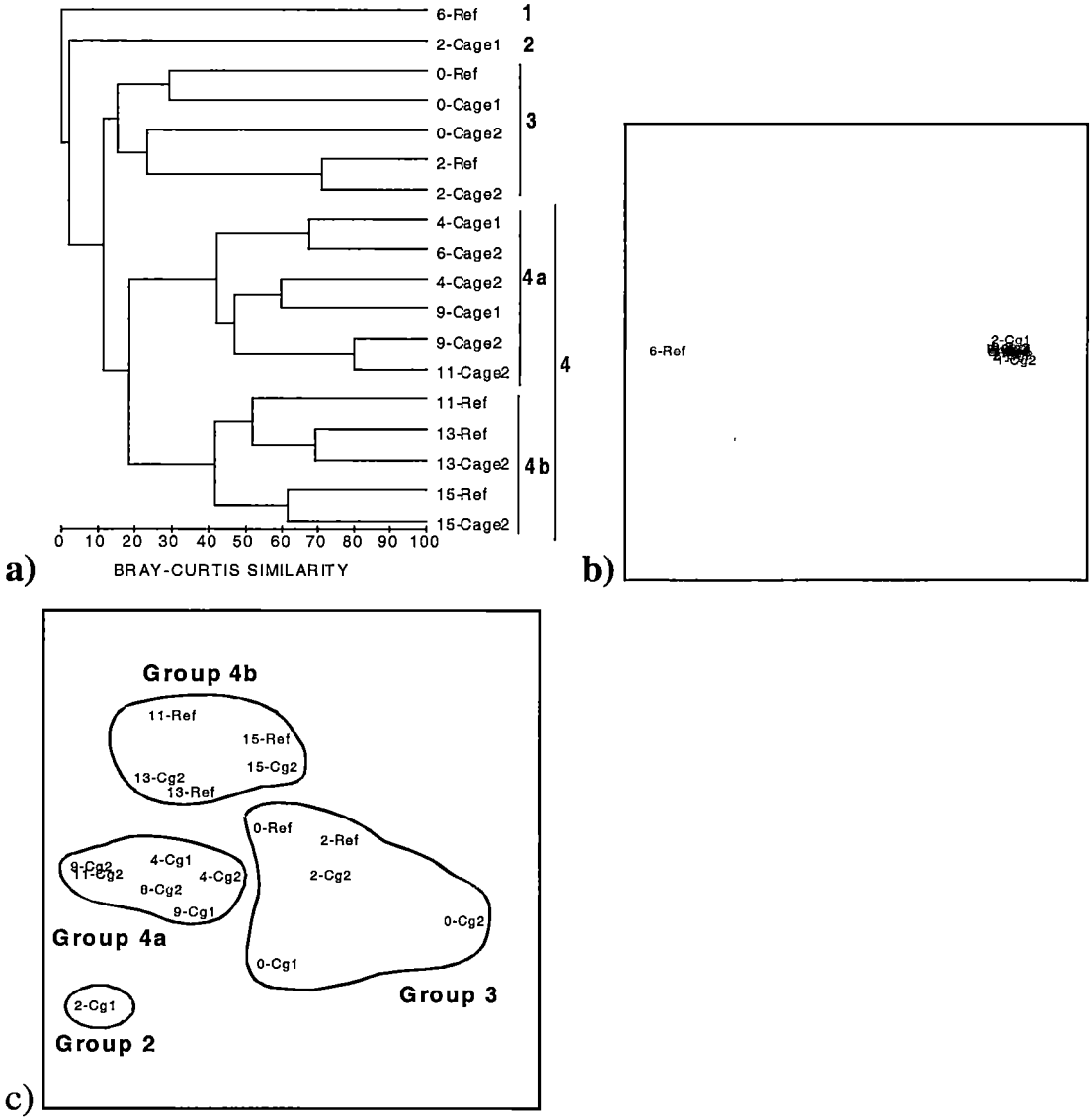


Figure 4.7 Species level identification of Phylum Mollusca from Nubeena. (reference and cage stations, replicates combined, over all sample times, data √√ root transformed) conducted on data identified to species level.

a) Dendrogram using group-average clustering from Bray-Curtis similarities

b) 2-dimensional MDS configuration of the 22 stations; cluster groups indicative of the primary dichotomy at a similarity level of 12% are shown outlined (Stress=0.01).

c) 2-dimensional MDS configuration of stations after removal of station 6-Ref (Stress=0.09).

Groups 3 and 4 appeared to have distinctly different community structures (SIMPER analysis – Table 4.10). Group 3 was dominated by bivalves; particularly *Theora fragilis*, *Nucula pusilla* and *Fulvia tenuicostata*, which together accounted for almost 71% of the within-group similarity. Group 4 was characterised by the gastropods *Polinices conicus*, *Maoricolpus roseus* and *Nassarius nigellus*, which together accounted for almost 90% of the group similarity.

Table 4.10 SIMPER output indicating a) and b) group average similarity and average abundance, ratio (average similarity/ st.dev. similarity) and % similarity of the most important molluscan species in each of the main groups at Nubeena.

a) Group 1 – Reference at 6 months. Single species recorded.

Species	Average Abundance	Ratio	% Similarity
Chiton sp.6	2.96	-	-

b) Group 2 – Cage 1 at 2 months. Single species recorded.

Species	Average Abundance	Ratio	% Similarity
Opistobranch sp.4	2.96	-	-

c) Group 3 – Cage 1 at 0 months; Cage 2 at 0 & 2 months; Ref. at 0 & 2 months. Group Average Similarity – 24.05

Species	Average Abundance	Ratio	% Similarity
Theora fragilis	6.07	0.61	27.05
Nucula pusilla	2.37	0.60	25.85
Fulvia tenuicostata	3.70	0.60	17.87
Nassarius nigellus	14.37	0.62	16.94
Hiatella australis	2.96	0.32	6.15

d) Group 4a – Cage 1 at 4 and 9 months; Cage 2 at 4, 6, 9 and 11 months. Group Average Similarity – 49.81

Species	Average Abundance	Ratio	% Similarity
Polinices sp.(conicus)	5.33	2.33	81.19

e) Group 4b – Cage 2 at 13 and 15 months; Reference at 11, 13 and 15 months. Group Average Similarity – 48.39

Species	Average Abundance	Ratio	% Similarity
Maoricolpus roseus	76.00	3.72	79.06
Nassarius nigellus	22.52	0.62	12.80
Polinices sp.(conicus)	2.37	0.32	4.44

The temporal pattern described above, could also be seen in the changes in the molluscan community structures within group 4. Group 4a was largely dominated by *Polinices conicus* (81% of the group similarity) whereas group 4b was dominated by *Maoricolpus roseus* (79% of the group similarity) and *Nassarius nigellus* (13% of

the group similarity) with *Polinices conicus* only contributing approximately 4% to the overall group similarity.

Sixty species of annelid were identified from Nubeena and analysis of these data yielded a pattern of station separation similar to that observed for full species assessment (Figure 4.1). RELATE analysis indicated a strong relationship between the two resulting matrices (Table 4.7). This is to be expected as annelids constituted 76 % of the overall faunal abundance at Nubeena.

Cluster analysis indicated two main groups (Figure 4.8 a,b) which separated at an overall similarity level of only 18%. Group 1 represented the unimpacted stations which typically contained a large number of species. The sedentary tentacular deposit feeding terebellid, *Pista australis*, was one of the characterising species of this group and accounted for 19% of the within-group similarity. Two burrowing

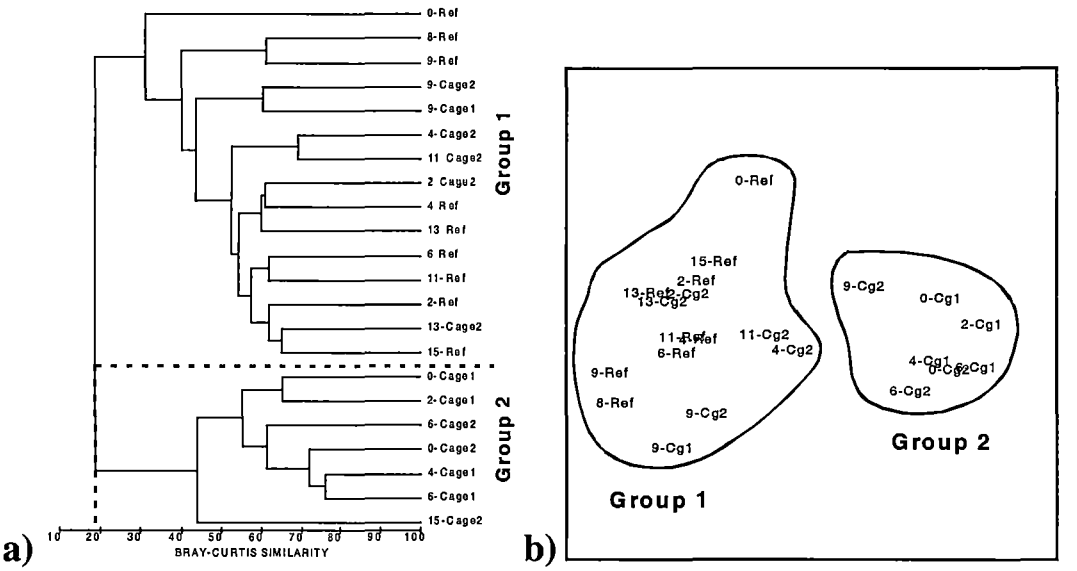


Figure 4.8 Species level identification of Phylum Annelida from Nubeena. (reference and cage stations, replicates combined, over all sample times, data √√ root transformed) conducted on data identified to species level.

a) Dendrogram using group-average clustering from Bray-Curtis similarities

b) 2-dimensional MDS configuration of the 22 stations; cluster groups indicative of the primary dichotomy at a similarity level of 18% are shown outlined (Stress=0.12).

deposit feeding polychaetes, *Mediomastus australiensis* and *Lumbrinereis* sp, were also important contributors to the overall group similarity, between them adding a further 27%. *Pista australis* was also an important species in distinguishing the two groups. Although this species did sometimes occur at the more impacted stations, its presence was unusual and always at relatively low abundance.

The second cluster group included the more impacted stations i.e. those with low species diversity and relatively high abundance levels. The stations within this group were most clearly characterised by the capitellid polychaete, *Capitella capitata* complex, which was responsible for 52% of the overall similarity of the stations. This species complex tended to be highly abundant displaying an average abundance per station of greater than 3000 individuals m^{-2}. Two other species, *Malacoceros tripartitus* and *Neanthes cricognatha*, were also important in characterising the stations within this group. Between them, these three species accounted for 92% of the within-group similarity (SIMPER analysis – Table 4.11).

Table 4.11 SIMPER output indicating a) and b) group average similarity and average abundance, ratio (average similarity/ st.dev. similarity) and % similarity of the most important annelid species in each of the main groups at Nubeena.

a) **Group 1** – Cage 1 at 9 months; Cage 2 at 2, 4, 9, 11 and 13 months; Reference at 0, 2, 4, 6, 8, 9, 11, 13 and 15 months.
Group Average Similarity – 46.62

Species	Average Abundance	Ratio	% Similarity
Pista australis	120.02	4.00	19.12
Mediomastus australiensis	143.11	1.85	15.83
Lumbrinereis sp.(MoV322)	15.57	2.26	11.23
Capitellidae sp.2	13.65	2.14	10.24
Eunice bassensis	5.63	1.01	5.46

b) **Group 2** – Cage 1 at 0, 2, 4 and 6 months; Cage 2 at 0, 6 and 15 months.
Group Average Similarity – 55.93

Species	Average Abundance	Ratio	% Similarity
Capitella capitata complex	3259.26	3.13	51.76
Malacoceros tripartitus	149.21	3.49	25.21
Neanthes cricognatha	115.66	1.16	15.14
Mediomastus australiensis	15.03	0.59	3.12
Pista australis	2.12	0.37	1.50

At Meads Creek echinoderms were absent from eight stations (0-Cage 2, 2-Cage 1, 4-Cage 1, 11-Cage 2, 11-Cage 1, 13-Cage 2, 15-Cage 2 and 15-Cage 1), all of which were determined to be impacted in the full species assessment. Cluster analysis divided the remaining stations into two groups, at a similarity level of 7% (Figure 4.9 a and b). The first of these groups contained the three remaining stations considered to be impacted after the full species assessment. SIMPER analysis (Table 4.12) showed that the species which contributed most to the differentiation of these stations was *Echinocardium cordatum*. In fact, as at Nubeena, this was the only species recovered from these stations. A total of six species of echinoderm were identified from Meads Creek and again, the distribution of heart urchins (*Echinocardium cordatum*) did not appear to reflect recruitment as there were both adult and juvenile specimens recorded from all three stations from June until January.

Table 4.12 SIMPER output indicating a) and b) group average similarity and average abundance, ratio (average similarity/ st.dev. similarity) and % similarity of the most important echinoderm species in each of the main groups at Meads Creek.

a) **Group 1** – Cage 1 at 6, 9 and 13 months. Single species recorded.
Group Average Similarity – 85.31

Species	Average Abundance	Ratio	% Similarity
Echinocardium cordatum	180.99	-	-

b) **Group 2** – Cage 1 at 0 months; Cage 2 at 2, 4, 6 and 9 months; Reference at 0, 2, 4, 6, 9, 11, 13 and 15 months.
Group Average Similarity – 64.13

Species	Average Abundance	Ratio	% Similarity
Amphiura elandiformis	46.44	4.32	95.64
Echinocardium cordatum	1.42	0.29	3.86

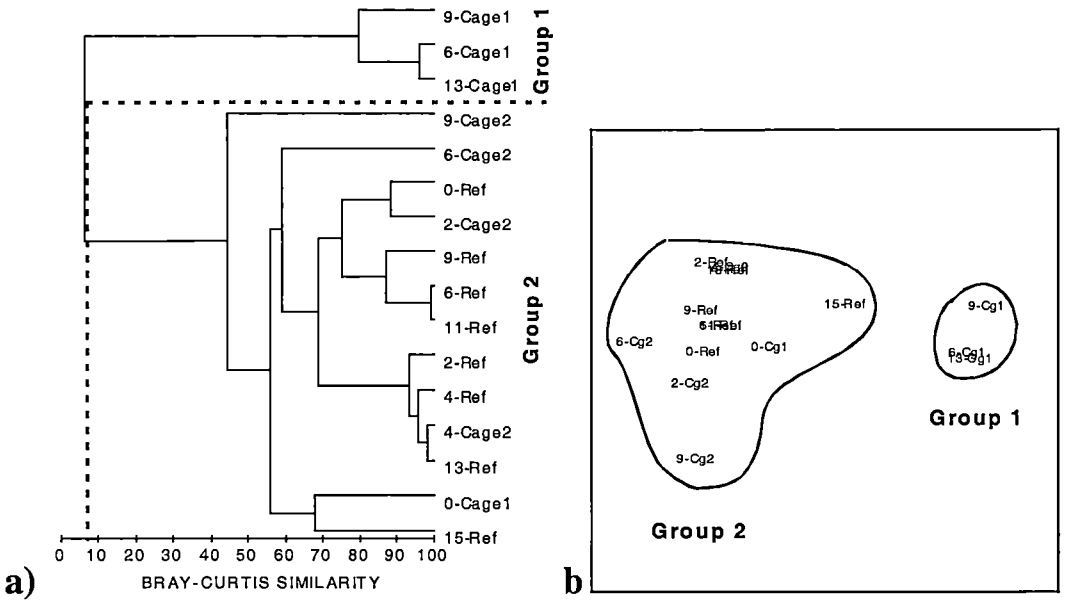


Figure 4.9 Species level identification of Phylum Echinodermata from Meads Creek. (reference and cage stations, replicates combined, over all sample times, data √√ root transformed) conducted on data identified to species level.

a) Dendrogram using group-average clustering from Bray-Curtis similarities

b) 2-dimensional MDS configuration of the 24 stations; cluster groups indicative of the primary dichotomy at a similarity level of 7% are shown outlined (Stress=0.03).

The second group (Figure 4.9 a and b) contained all of the stations which had been identified as unimpacted by the full assessment. This group was characterised by the brittle star *Amphiura elandiformis* which accounted for 96% of the within group similarity (Table 4.12). The absence of this brittle star and the presence of *Echinocardium cordatum* was also important in distinguishing between the two groups.

Once more, RELATE analysis indicated that there was a strong relationship between the echinoderm rank correlation matrix and that resulting from the full species assessment (Table 4.13).

In the assessment of crustacea at Meads Creek sixty five species, representing approximately 35% of the total were identified. Crustacean fauna were absent from

three stations (9-Cage 1, 13-Cage 1 and 15-Cage 1), all of which were described as impacted in the full species assessment.

Table 4.13 RELATE analysis results, Meads Creek. Comparison of major faunal groups with species level identification.

Taxonomic Level	Global RHO	Significance
Echinodermata	0.714	<0.001
Crustacea	0.622	<0.001
Mollusca	0.542	<0.001
Annelida	0.926	<0.001

Station 11-Cage 2 was distinguished early in the analysis with an overall similarity level to the remaining stations of only 5% and may be considered an outlier in further analysis. The crustacean fauna at this station was very poorly represented and was quite different from any of the other stations. Single individuals of only two species were recorded (an isopod - *Gnathia calamitosa* and a decapod zoea). The remaining two groups (Figure 4.10 a, b) broadly separated the rest of the sites in accordance with the unimpacted (group 2) and impacted (group 3) groupings identified in the full assessment (Figure 4.3). Had the stations with no crustacea present been included in group 3 (impacted) it would have contained all of the impacted stations from the full species level assessment. However, 0-Cage 1 (previously described as unimpacted) was also included in group 3.

SIMPER analysis (Table 4.14) indicated that the fauna at the group 2 stations was dominated by burrowing crustacean species such as the small ostracod - *Euphilomedes* sp (MoV14), the squat lobster - *Munida haswelli*, and two species of Callianassid (*Callianassa limosa*, *Callianassa arenosa*). Between them these species accounted for 52% of the overall group similarity. The fauna at the group 3 stations was characterised by the free swimming leptostracan, *Nebalia* sp., which was responsible for 69% of the overall similarity. These were also the species that best distinguished the groups. *Nebalia* sp. was recorded from one of the replicates at station 0-Cage 1 probably accounting for this station's inclusion within the impacted group.

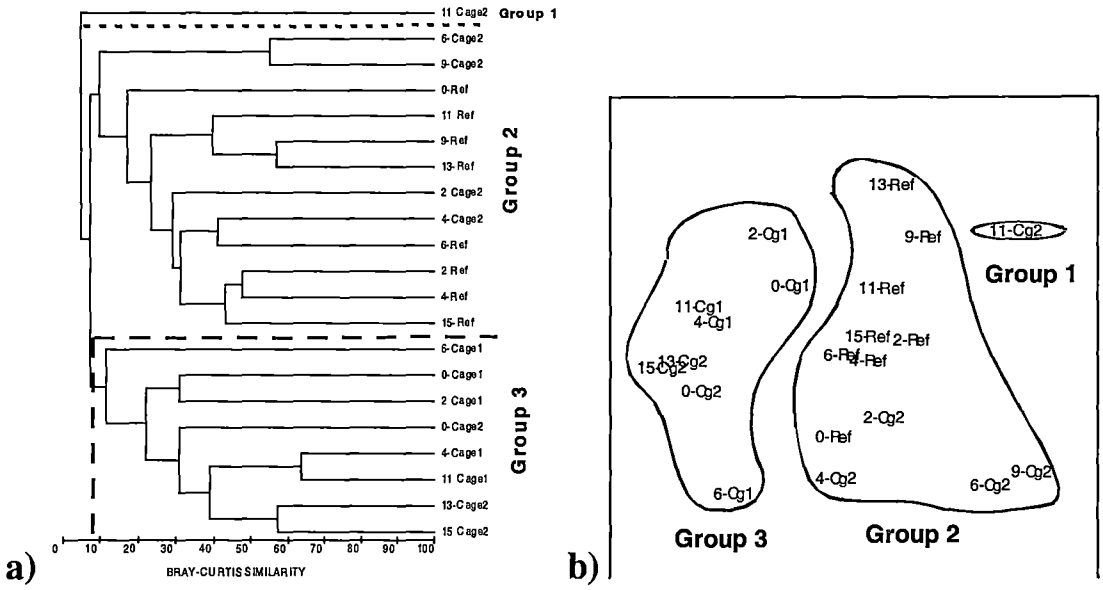


Figure 4.10 Species level identification of Phylum Arthropoda (Crustacea) from Meads Creek. (reference and cage stations, replicates combined, over all sample times, data √√ root transformed) conducted on data

a) Dendrogram using group-average clustering from Bray-Curtis similarities

b) 2-dimensional MDS configuration of the 24 stations; cluster groups indicative of the primary dichotomy at a similarity level of 7% are shown outlined (Stress=0.03).

Again, the ranked similarity matrices of the crustacean assessment and the full species level assessment corresponded well (Table 4.13).

Two stations (2-Cage 1 and 4-Cage 1) were excluded from this assessment as no molluscs were recorded. Both stations were identified within the impacted group by the full species level assessment (Figure 4.3). Overall, 34 species of mollusc were recorded, representing approximately 18% of the total number of species identified.

Station 6-Cage 2, (group 1; figure 4.11 a, b) separated from the main groups at a similarity level of only 6% suggesting its status as an outlier. Only two species, an opisthobranch and an aplacophoran (*Falcidens chiastof*), were identified from this station. Both of these species were found at other stations at Meads Creek but their occurrence was rare.

Table 4.14 SIMPER output indicating a) and b) group average similarity and average abundance, ratio (average similarity/ st.dev. similarity) and % similarity of the most important crustacean species in each of the main groups at Meads Creek.

a) Group 1 – Reference at 6 months. Single station, only two species recorded.

Species	Average Abundance	Ratio	% Similarity
Gnathia calamitosa	2.96	-	-
Decapod Zoea	2.96	-	-

b) Group 2 – Cage 2 at 2, 4, 6 and 9 months; Reference at 0, 2, 4, 6, 9, 11, 13 and 15 months.
Group Average Similarity – 22.32

Species	Average Abundance	Ratio	% Similarity
Euphilomedes sp.(MoV1021)	8.15	0.64	17.52
Munida haswelli	2.72	0.47	12.35
Callianassa limosa	5.25	0.66	11.42
Callianassa arenosa	6.05	0.64	11.19
Oedicerotidae sp.	1.98	0.52	8.27

c) Group 3 – Cage 1 at 0, 2, 4 and 6 months; Cage 2 at 0, 13 and 15 months.
Group Average Similarity – 26.37

Species	Average Abundance	Ratio	% Similarity
Nebalia longicornis	106.42	1.26	69.09
Leptochelia dubia	2.10	0.34	9.57
Callianassa arenosa	3.33	0.31	7.62
Dittosa undecimspinosa	1.73	0.19	5.18
Callianassa limosa	1.11	0.19	2.63

The remaining stations separated into two groups with an overall similarity level of approximately 18%. It is interesting that, as for the molluscs at Nubeena, the divergence of these groups occurred largely with respect to the time of sampling. Group 2 was mainly composed of the earlier samples and group 3 the later ones.

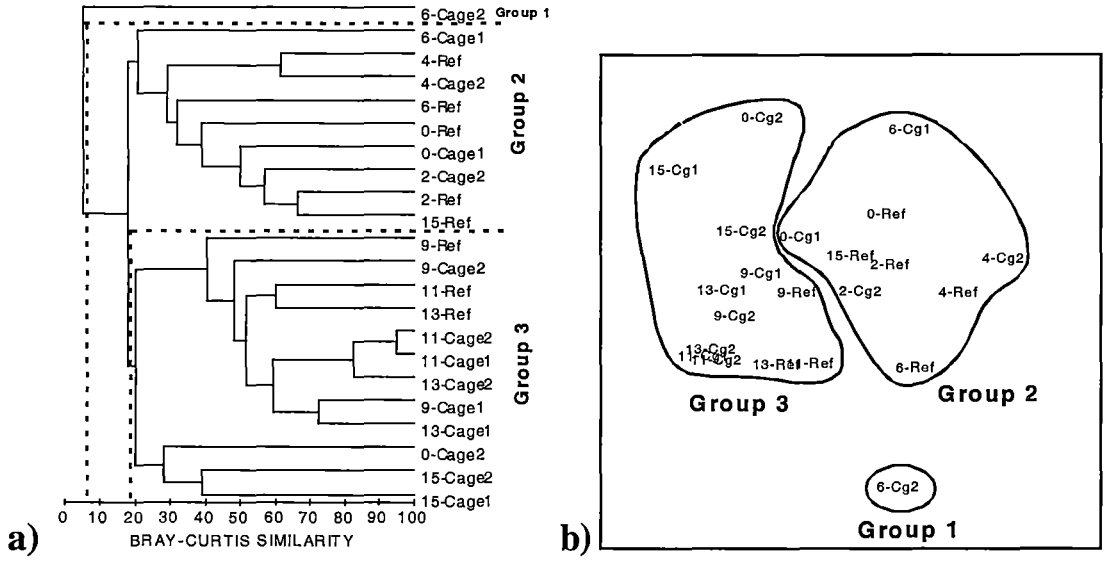


Figure 4.11 Species level identification of Phylum Mollusca from Meads Creek. (reference and cage stations, replicates combined, over all sample times, data √√ root transformed) conducted on data identified to species level.

a) Dendrogram using group-average clustering from Bray-Curtis similarities

b) 2-dimensional MDS configuration of the 24 stations; cluster groups indicate the first and second dichotomy at similarity levels of 6% and 18% respectively (Stress=0.15).

As at Nubeena, the fauna associated with these groups indicated that they also separated according to the extent of bivalve / gastropod dominance. Group 2 was characterised by bivalve species, *Thyasira adelaideana*, *Theora fragilis* and *Nucula pusilla*: which together accounted for 63% of the overall group similarity (SIMPER - Table 4.15). In contrast, the group 3 stations were characterised by two species; *Maoricolpus roseus*, an introduced gastropod which represented 80% of the group similarity and *Nassarius nigellus* which contributed a further 16%. As a result, 96% of the overall group similarity was attributable to gastropod molluscs. It is also noteworthy that most of the stations contained within Group 3 had been determined to be impacted by the full species level assessment (Figure 4.3).

There were two exceptions to the temporal pattern of station separation. The reference station at the final sampling (15 months) clustered with group 2 (Figure 4.11) due to the presence of several species of bivalve albeit at low abundance levels.

Similarly, station 0-Cage 2 clustered with group 3 due to the presence of the small dog whelk, *Nassarius nigellus* (again at low abundance levels).

Table 4.15 SIMPER output indicating a) and b) group average similarity and average abundance, ratio (average similarity/ st.dev. similarity) and % similarity of the most important molluscan species in each of the main groups at Meads Creek.

a) Group 1 – Cage 2 at 6 months. Single station, only two species recorded.

Species	Average Abundance	Ratio	% Similarity
Opistobranch sp.8	5.93		
Falcidens chiastof	5.93	-	-

b) Group 2 – Cage 1 at 0 and 6 months; Cage 2 at 2 and 4 months; Reference at 0, 2, 4, 6 and 15 months. Group Average Similarity – 34.10

Species	Average Abundance	Ratio	% Similarity
Thyasira adelaideana	20.49	1.09	25.15
Theora fragilis	14.49	0.75	23.11
Nucula pusilla	13.50	0.79	14.31

c) Group 3 – Cage 1 at 9, 11, 13 and 15 months; Cage 2 at 0, 9, 11, 13 and 15 months; Reference at 9, 11 and 13 months. Group Average Similarity – 26.37

Species	Average Abundance	Ratio	% Similarity
Maoricolpus roseus	97.72	1.22	79.75
Nassarius nigellus	41.81	0.63	16.49
Theora fragilis	15.56	0.12	1.02

At Meads Creek 67 species or approximately 36% of the total species identified were annelids. Importantly however, annelids represented 78% of the total number of individuals recorded. Consequently, it might be expected that the pattern of station distribution for the annelids should more closely resemble that of the full community assessment. In this context, RELATE analysis (Table 4.13) indicated a very strong relationship between the rank similarity matrices for the full assessment and the species level annelid assessment. Two main groups could be distinguished (Figure 4.12 a and b) containing exactly the same stations as the corresponding groups in the full assessment.

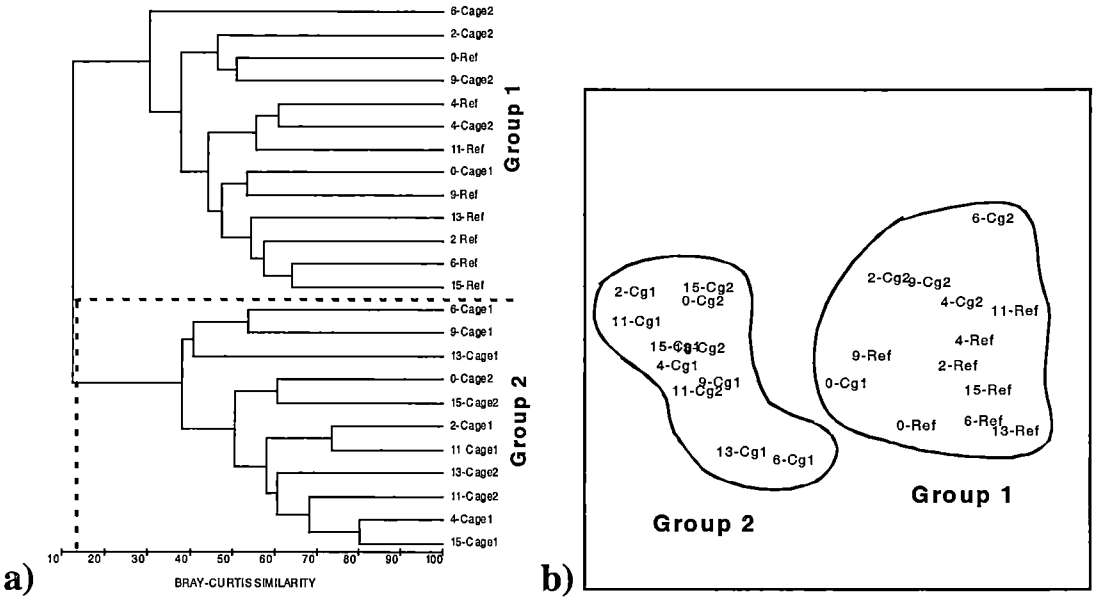


Figure 4.12 Species level identification of Phylum Annelida from Meads Creek. (reference and cage stations, replicates combined, over all sample times, data √√ root transformed) conducted on data identified to species level.

a) Dendrogram using group-average clustering from Bray-Curtis similarities

b) 2-dimensional MDS configuration of the 24 stations; cluster groups indicative of the primary dichotomy at a similarity level of 12% are shown (Stress=0.11).

The stations comprising group 1 (unimpacted) generally had a greater diversity of species than those from group 2 (impacted) and no single species dominated. The two burrowing deposit feeding polychaetes (*Mediomastus australiensis* and *Lumbrinereis* sp.) observed at Nubeena were also present in the Meads Creek samples. At Meads Creek a species of sedentary tentacular deposit feeding terebellid was also characteristic of the group 2 stations. However, in this case, the species was *Lysilla jennacubinae* rather than *Pista australis*. Again, the group 2 stations were characterised by *Capitella capitata* complex which accounted for 69% of the overall similarity (SIMPER analysis – Table 4.16). Two species of nereid, *Simplisetia amphidonta* and *Neanthes cricognatha*, also appeared to be characteristic of group 2. Together these species contributed a further 23% to the overall group similarity (Table 4.16). The presence of *Capitella capitata* complex in itself was not sufficient

to distinguish between the two groups. However, the relative abundance of this organism was a characterising feature.

Table 4.16 SIMPER output indicating a) and b) group average similarity and average abundance, ratio (average similarity/ st.dev. similarity) and % similarity of the most important annelid species in each of the main groups at Meads Creek.

a) Group 1 – Cage 1 at 0 months; Cage 2 at 2, 4, 6 and 9 months; Reference at 0, 2, 4, 6, 9, 11, 13 and 15 months. Group Average Similarity – 41.94

Species	Average Abundance	Ratio	% Similarity
Mediomastus australiensis	42.17	2.76	12.54
Lumbrinereis sp.(MoV322)	19.26	2.00	10.28
Lysilla jennacubinae	20.23	1.38	9.49
Asychis sp.(MoV13079)	17.09	1.08	8.18
Terebellides stroemii	10.48	1.39	7.43

b) Group 2 – Cage 1 at 0, 2, 4, 6, 9, 11, 13 and 15 months; Cage 2 at 0, 11, 13 and 15 months. Group Average Similarity – 48.20

Species	Average Abundance	Ratio	% Similarity
Capitella capitata complex	2914.59	2.08	69.14
Simplisetia amphidonta	8.51	0.95	13.38
Neanthes cricognatha	11.02	0.73	10.34
Malacoceros tripartitus	10.42	0.32	3.63
Aschyis sp.(MoV13079)	0.81	0.24	1.42

4.3.3 Assessment of phylum Annelida at species, family and order level.

Annelids were the only faunal group recorded at all stations. Assessment of the distribution of the annelids indicated that this was the faunal group which most closely reflected the full community species level assessment. Consequently, the annelid communities at both sites were assessed at higher taxonomic levels to determine whether this relationship was maintained.

As previously described, species level assessment of the annelids (Figure 4.13a) grouped the stations in accordance with the full community assessment. However, assessment of the annelids alone required identification of only 69 species whereas the full community assessment required 232 species identifications. Therefore species level identification of the annelids alone required only approximately 30% of the identification effort.

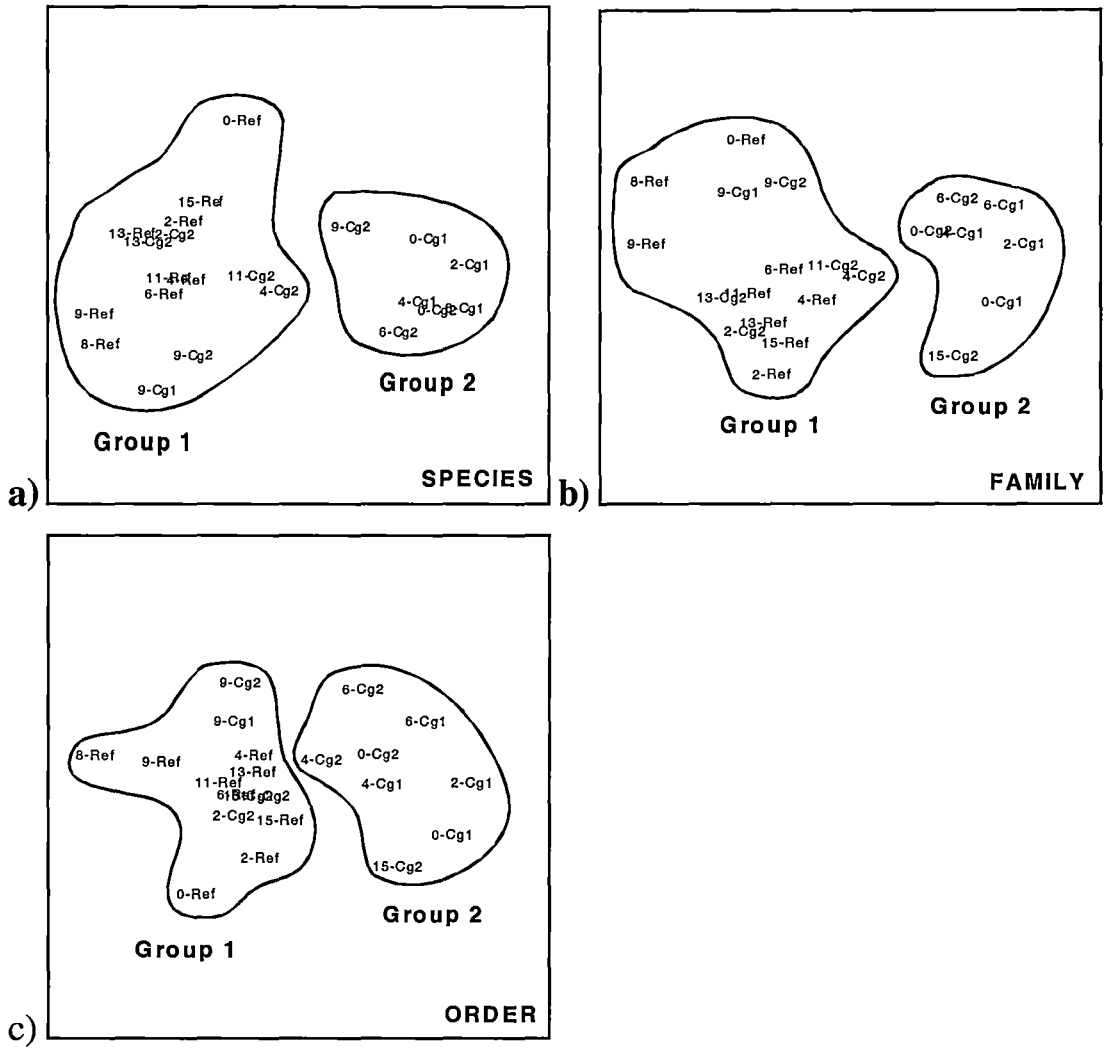


Figure 4.13 Phylum Annelida – Nubeena. Two-dimensional MDS configurations of the 22 stations included in the temporal study, replicates combined, over all sample times, data √√ root transformed; cluster groups indicative of the primary dichotomy are shown outlined. Identification at a) species level (Stress=0.12), b) family level (Stress=0.12), c) order level (Stress=0.11).

Family level identification (Figure 4.13b) maintained the group and station separation observed at species level albeit at an overall similarity level of 18% (i.e. lower than that of the full community assessment). At this level of analysis only 31 identifications were required, reducing the taxonomic effort to only 13% of that required for the full community assessment. The main family characterising the station separations was Capitellidae.

A decline in separation was observed at order level (Figure 4.13c), when station 6-Cage 1 clustered within group 2.

At Meads Creek the species level assessment of annelids (Figure 4.14a) also reproduced the station groups yielded by the full community assessment. Here assessment of the full community involved the identification of 185 species whilst evaluation of the annelids alone required identification of only 67 species or 36% of the full species identification effort.

Separation was maintained with identification to family level (Figure 4.14b) and required the identification of only 29 taxa, further reducing the effort to only 16% of that required for full assessment. As at Nubeena, the main family influencing group separation was Capitellidae.

Once again, the first decline in separation became apparent at order level (Figure 4.14c), when station 0-Cage 1 clustered with group 2 in place of station 6-Cage 1 which was only distinguishable at the second dichotomy (data not shown). Nevertheless, most of the impacted stations continued to be discernible at order level. Assessment at order level required only 10 identifications or 5% of the effort required for full assessment.

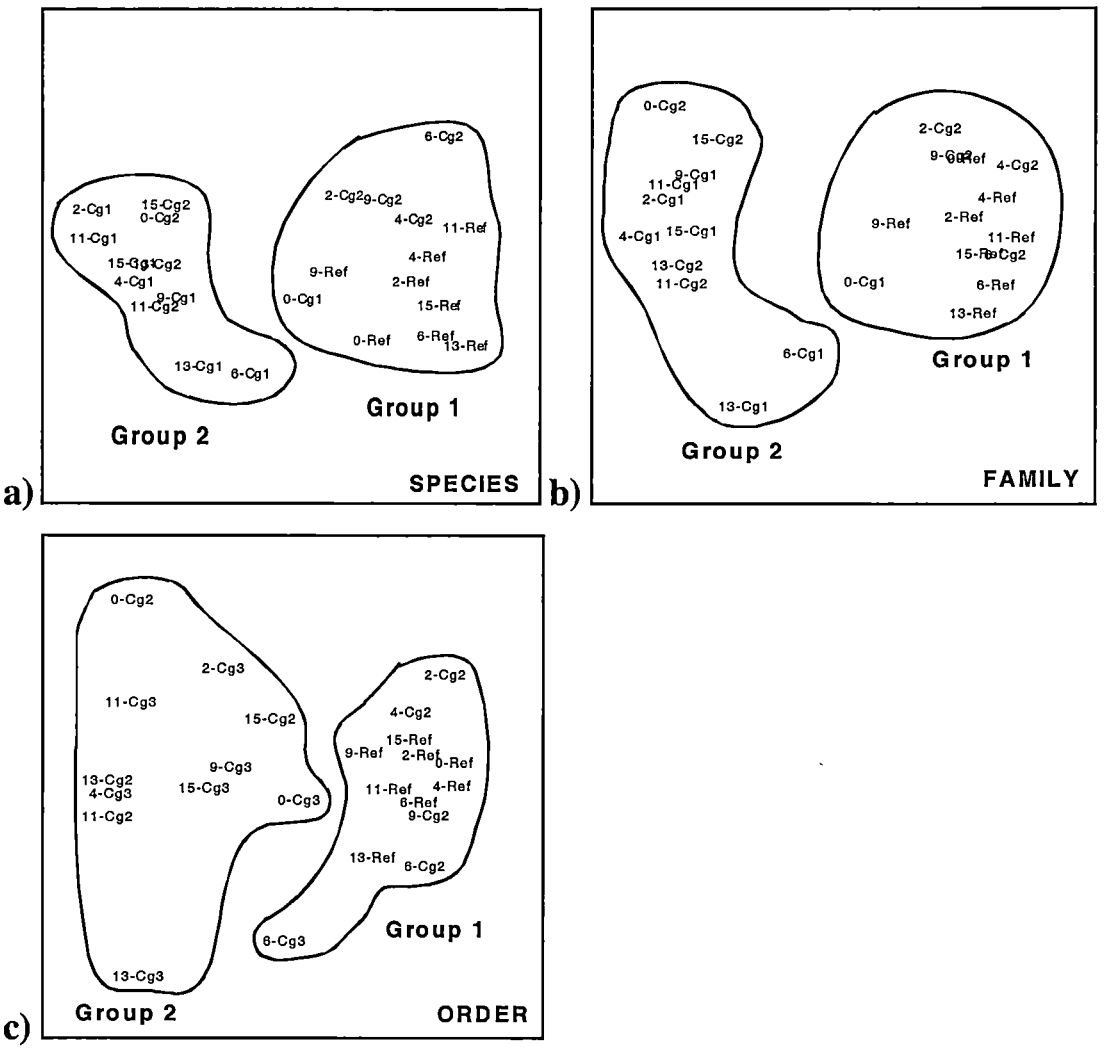


Figure 4.14 Phylum Annelida – Meads Creek. Two-dimensional MDS configurations of the 22 stations included in the ongoing study, replicates combined, over all sample times, data $\sqrt{\sqrt{}}$ root transformed; cluster groups indicative of the primary dichotomy are shown outlined. Identification at a) species level (Stress=0.11), b) family level (Stress=0.13), c) order level (Stress=0.13).

4.4 Discussion

4.4.1 Review of species level community assessment.

Full species level community assessment has been described as the most sensitive approach to evaluation of benthic condition (Warwick and Clarke, 1991). As the community structure is inherently multivariate then the best analysis techniques to represent this community structure must also be multivariate. The results from the

Cluster analyses and MDS ordinations of the full species level assessments at each of the study sites indicated stations groups and patterns of species distribution which can be clearly associated with the level of organic enrichment. At both sites two main groups of stations could be identified. At each site one of these groups displayed a community structure which was indicative of a disturbed environment (group 1 at Nubeena and group 2 at Meads Creek). The classification and species composition of these groups is discussed in full in Chapter 3. However, in order to assist comparison of other assessment methods, the primary features are outlined again below.

The stations in the disturbed groups at both sites were dominated by *Capitella capitata*, a species complex known to be associated with organically enriched conditions (Pearson and Rosenberg, 1978, Brown et al., 1987, Weston,1990, Lim, 1991, Hargrave et al.,1993). The impacted stations also recorded lower numbers of species compared with stations in the unimpacted groups. The unimpacted groups generally displayed high species diversity and low faunal dominance levels and were characterised by species which were poorly adapted for areas of organic enrichment.

At Nubeena one of the principal species recorded from the unimpacted stations was a terebellid polychaete, *Pista australis*. This species is a surface deposit feeder with long grooved buccal tentacles which are spread across the sediment surface. In areas with high levels of sedimentation this species may be unable to cope with the increased levels of deposition and is likely to be disadvantaged. *Mediomastus australiensis*, another member of the family Capitellidae, was also frequently recorded from unimpacted stations. This species, like all capitellids, is a burrowing deposit feeder, but unlike its relative *Capitella capitata* complex it is not quite as well adapted to areas of high organic enrichment and is more usually reported from areas of moderate enrichment (Pearson and Rosenberg, 1978; Brown et al., 1987).

At Meads Creek the brittle star *Amphiura elandiformis* was an important species at the unimpacted stations. This species feeds on both surface deposited material and by pseudo-filter feeding where it uses its arms to trap particles suspended in the overlying water. It appears that this species is capable of adapting to low levels of organic material in the sediments. However, once again, large amounts of suspended and deposited matter will be inhibitory.

4.4.2 Increased Taxonomic Level.

Decreasing the level of taxonomic resolution of the full community assessment produced some interesting results. At family level there was no effect on the pattern of station separation at Meads Creek, however at Nubeena two stations were lost from the impacted group. These stations were those positioned closest to the unimpacted cluster grouping in the full assessment ordination (Figure 4.1). This tends to suggest that the two stations were influenced by a less severe disturbance than the other stations in the impacted group. In this regard, several studies have indicated that the level at which the community is affected corresponds to the degree of environmental stress i.e. small disturbances are reflected at species level whereas acute pollution effects are seen at higher taxonomic levels (Pearson and Rosenberg, 1978; Warwick, 1988b, 1988c; Ferraro and Cole, 1990, 1992; James et al. 1995). Nonetheless, at Nubeena family level identification continued to discriminate those stations where a significant impact had occurred, and may provide sufficient discrimination for farm based assessment.

At Meads Creek 56% of the taxa identified at family level comprised single species families whereas at Nubeena only 46% of the families were represented by single species, indicating that the station ordination was closer to the species level representation at Meads Creek than at Nubeena. This may account for some of the difference in discrimination between the two sites. Family level identification resulted in a reduction in the number of identifications required by approximately 50% at Nubeena and 45% at Meads Creek, representing a considerable saving in both time and effort.

Order level discrimination produced the same pattern of station separation as provided by family level. However, identification to order level can be achieved with less than one quarter of the taxonomic effort required for the full species level assessment. Class level identification resulted in the first change in the pattern of station separation at Meads Creek. Class level identification also resulted in the loss of a further station from the impacted group at Nubeena while phylum level identifications resulted in even further reduction in station separation at both sites.

It is noteworthy that, at Nubeena, the stations which separated from the two main groups as taxonomic level increased appeared to do so in relation to the intensity of

impact and that the stations which remained in the impacted group at phylum level were the most impacted. The inclusion or exclusion of a station from the impacted group appeared to be directly related to the level of organic enrichment at that station. This supports the observations of Warwick, (1988) and Gray et al., (1988) who suggested that results based on higher taxa may more closely reflect the gradients of contamination or stress than those based on species data. Ferraro and Cole (1990) suggested that the taxonomic level necessary to adequately assess change increases in a stepwise manner. The present data appear to indicate that the most severe impacts could still be discerned at phylum level, major impacts at class level and moderate impacts at family/order level, whilst species level appeared to detect minor disturbances.

At Meads Creek the ordinations produced with increased taxonomic level also tended to show station separation in relation to the level of impact encountered. The same stations were distinguished at species, family and order level suggesting a significant impact at these stations and that all stations were affected to the same extent. The first separation of stations from the impacted group occurred at class level. However, one of these stations (15-Cage 1) was included again at phylum level. Class level data for this station was characterised by several species which were indicative of organic enrichment but which were only represented by single individuals in each of the replicates, giving an appearance of greater diversity than was actually the case. Importantly the eight most impacted stations were included in the phylum level group.

The most appropriate taxonomic level at which to conduct an assessment will therefore depend on the degree of impact to be detected. Clearly, a minor impact will not be detected by identification at high taxonomic levels.

The communities at the two sites appeared to respond to organic enrichment in different ways. At Meads Creek all impacts were reflected at a high taxonomic level with no stations moving between groups below class level, possibly suggesting that all impacts were fairly major at that site. In contrast, at Nubeena, stations moved between groups at family level or above, possibly indicating that either the impacts were not as severe or that the environment at this site was more resilient. This contrasts with the species level results from the temporal and spatial surveys which

suggested that the Meads Creek site was the more resilient and possibly pre-adapted to some level of organic enrichment.

4.4.3 Major Faunal Groups.

4.4.3.1 Echinodermata

Gray et al. (1988), in a study of the Frierfjord/Langesundfjord macrofauna, suggested that increases in the abundance and biomass of echinoderms were generally associated with a reduction in the degree of pollution. Thus, while many species of echinoderm, particularly asteroids and ophiuroids, are fairly mobile, opportunistic deposit feeders and scavengers which will survive in areas with low levels of organic enrichment, the echinoids are more generally restricted to unpolluted areas.

Few species of echinoderm were recorded at each site (10 and 6 from Nubeena and Meads Creek respectively) and the response of the echinoderm fauna to the varying levels of organic enrichment was consistent at both sites. Echinoderms were absent from the most impacted stations. Stations where *Echinocardium cordatum* was the only species of echinoderm recorded could be characterised as moderately impacted. These stations, in conjunction with the "no echinoderm" stations, were generally the stations which made up the impacted group according to the full community assessment. This suggests that this heart urchin was able to tolerate higher levels of organic enrichment than the other species of echinoderm. The remaining "unimpacted" stations contained a range of echinoderms but tended to be dominated by *Amphiura elandiformis*.

As previously discussed (chapter 3), the reference station from the spatial survey at Nubeena appeared to be slightly different to the other reference station samples. Full species assessment indicated that this station was not significantly disturbed however, the faunal composition differed from that recorded from the same station at all other times. Of the several faunal differences apparent at that time, one important one was the presence of *Echinocardium cordatum* and the corresponding absence of *Amphiura elandiformis*. Interestingly, the heart urchins found at this station were all large adult specimens indicating that the difference was not a result of recruitment. In the spatial survey cluster analysis (chapter 2) this station was most closely associated with between cage stations suggesting that it may have been influenced by a low level of organic enrichment. However, redox measurement indicated no difference

from other stations beyond the farm boundary. Relative inexperience with the sampling techniques might also provide an explanation for difference observed at this stage as the brittle stars could only be accurately identified and counted where basal discs were present and it is possible that during the spatial survey, basal discs may have been overlooked. It is also possible that some other environmental factor was influencing the station at that particular time. Unfortunately, as only a single reference station was monitored it is not possible to comment further.

Together, these results suggest that assessment of echinoderms could represent a simple and useful indicator of sediment health, that complete absence of echinoderms appears to be indicative of highly enriched conditions. Similarly, stations where the only echinoderm present is *Echinocardium cordatum* might be considered moderately impacted. Fauna at unimpacted stations was characterised by a range of echinoderm species and was generally dominated by *Amphiura elandiformis*.

4.4.3.2 Crustacea

The crustacea are represented in the benthic fauna by species which cover all community niches. There are burrowing crustaceans, surface feeding scavengers, tube dwelling detrital and suspension feeders and free swimming individuals which feed at the sediment surface. Consequently, it might be expected that changes in the level of organic enrichment would be reflected by changes in the crustacean community.

There were considerably more species included in the crustacean assessment than for the echinoderms. At Meads Creek three of the most impacted stations recorded no crustacean fauna whereas all stations at Nubeena were represented. At Nubeena, only two stations (the two most impacted stations) were clearly distinguished by the crustacean assessment.

Nebalia sp., an opportunistic leptostracan, often associated with areas of decaying plant matter or organic material (Edgar, 1997) was found to be most representative of the impacted groups at each site. Generally, the stations did not separate in accordance with the full species assessment and there was greater overlap between unimpacted and impacted stations, particularly at Nubeena. The primary species characterising the unimpacted groups were different at both sites. Unimpacted

stations at Nubeena were largely characterised by phoxocephalid amphipods whereas an ostracod, a galatheid lobster and two species of callianassid shrimp were the most significant species at Meads Creek. In spite of the differences between the sites, these species are all representatives of a similar functional group i.e. they are all burrowing species.

The differences between the two sites suggest that the community structures may be influenced by environmental factors other than the level of organic enrichment. The crustacean community is generally quite mobile and can move away from, or indeed towards, areas of organic enrichment with relative ease. Moderate organic enrichment appeared to be reflected by a change in abundance levels rather than an actual change in the species composition. It may be that increased organic enrichment does not change the crustacea as markedly as it does other faunal groups and that major faunal change occurs only at high levels of organic input.

The data suggest that increasing levels of organic enrichment result in the replacement of burrowing species by opportunistic free swimming species (eg. *Nebalia* sp.), which are well adapted to scavenge the organic material from under the cages. When the level of organic deposition is sufficiently high the crustacea are ultimately eliminated.

4.4.3.3 Mollusca

Molluscs, particularly the bivalves, are generally fairly immobile organisms and as such, changes in the molluscan community can accurately reflect changes in environmental conditions. Many species of mollusc are known to be tolerant of relatively high levels of organic enrichment and there are many opportunistic species (Pearson and Rosenberg, 1978).

At both sites the stations showed a very interesting temporal pattern in the molluscan community structure changing from bivalve (*Theora fragilis*, *Nucula pusilla* and *Fulvia tenuicostata*) to gastropod domination. Furthermore, over time, the gastropods at Nubeena could be further separated into two groups each with differing characterising species. Initially the dominant gastropod was *Polinices conicus*, a native predatory species but with time, *Maoricolpus roseus*, a highly adaptable introduced species, became dominant. This progression does not reflect the pattern of impact identified by the species assessment. However, it does indicate a progression

over time within the whole study area (reference stations included) and leads to the question; was this change unrelated to the presence of the farm or was the presence of the farm and the associated environmental disturbance responsible for the change? If the latter was the case then it would suggest that the reference stations were also influenced by the farm. However, in this case the reference stations exhibited the community change prior to the cage stations, suggesting that the change had an external origin.

At Meads Creek separation also appeared to be temporally influenced with progression from bivalve (in this case *Thyasira adelaideana*, *Theora fragilis* and *Nucula pusilla*) to gastropod dominance (*Maoricolpus roseus*). A possible explanation at this site might be that the introduced gastropod colonised areas where there had been disturbance (perhaps as a result of organic enrichment) and established itself in those areas before spreading throughout the lease to become the dominant species in later samples. However, while this would explain the main ordination division it does not account for the two stations with no molluscs recorded (2-Cage 1 and 4-Cage 1), the presence of the reference station at 15months in group 2 or the lack of *M.roseus* at station 0-Cage 2.

Another possible explanation for the temporal change from bivalves to gastropods may be trophic amensalism. This concept, first suggested by Rhoads andYoung (1970), suggests that suspension and deposit-feeders are environmentally incompatible; deposit feeders create instability in the sediment and inhibit the suspension feeders. This could explain the complete change in the dominance within each group but would not provide the reason for the change. The increased organic load and sedimentation associated with cage culture may make the environmental conditions unsuitable for the filter feeding bivalves and provide an opportunity for the gastropods to become dominant. However, an equivalent change was observed in the community structure at the reference stations where, according to the other parameters measured (Chapters 2 and 3) there was no organic enrichment. This perhaps suggests that the gastropods and in particular the introduced species, are themselves the agents of change.

4.4.3.4 Annelida

The polychaetes are well recognised as being amongst the most important components of the benthic community and in soft sediments they are often the dominant faunal group (Beesley et al., 2000). Many studies and reviews have documented the changing patterns within the polychaete communities associated with sources of organic enrichment (eg. Pearson and Rosenberg, 1978; Gray, 1979; Gray et al., 1990; Weston, 1990; Snelgrove and Butman, 1994) and the polychaetes are often the group which most clearly reflects the changes associated with organic enrichment. In particular, *Capitella capitata* complex is recognised globally as a taxon which is indicative of organic enrichment (Pearson and Rosenberg, 1978, Brown et al., 1987, Johannessen et al., 1994).

In this study Annelida was the faunal group which most closely reflected changes in the full community structure. At both sites annelid assessment distinguished exactly the same stations as the full community assessment. In the unimpacted groups the main species responsible for determining level of impact differed at each of the two sites. At Nubeena, the unimpacted group was characterised by three species: the surface deposit feeder *Pista australis* and the subsurface deposit feeders *Mediomastus australiensis* and *Lumbrinereis* sp. The two subsurface deposit feeders were also recorded at Meads Creek. However, probably as a result of the greater levels of background sedimentation and organic matter, surface deposit feeders were not a significant component of the fauna at Meads Creek. The impacted stations at both sites were clearly characterised by *Capitella capitata* complex. The abundance of this species very clearly categorised station condition.

4.4.4 Conclusions

In summary, the crustacean component of the fauna did not appear to be very useful as an indicator of faunal response to changing conditions. The molluscs clearly displayed a pattern of effect but it is unclear whether or not this effect was a function of the environmental impact from the farm. Consequently, the molluscs can not be recommended to farmers as a reliable indicator of sediment condition. Nonetheless, the pattern of change in itself is very interesting and would be worthy of further investigation as it may have implications for future compliance monitoring.

Assessment of the echinoderm and annelid distributions seem to be the most useful approach in regard to farm based monitoring of lease condition and the assessments were consistent at both sites. The echinoderms may be extremely useful for a rapid appraisal of environmental status as their complete absence indicated very impacted conditions, while dominance by *Echinocardium cordatum* indicated moderately impacted conditions and a more diverse fauna, with a strong presence of *Amphiura elandiformis,* was associated with relatively undisturbed conditions. From the taxonomic perspective, assessment of this component of the fauna was simple, as few species were present and the identification of species was relatively easy. However, on a cautionary note, in order to ensure the appropriateness of echinoderm assessment at other sites the assessment should be preceded by a full species level community study.

In this context, evaluation of the annelid component of the fauna alone appeared to be a suitable alternative to full species assessment. This approach distinguished exactly the same stations and patterns as did the full community analysis with no loss of discrimination. Importantly, assessment of this sub-group of the community saves considerable taxonomic effort.

As previously mentioned, species level identification of the annelids gave the same ordination results as the full community assessment but significantly, identification of the annelids to family level also maintained those group and station separations and only at order level did the pattern begin to break down. Consequently, identification of annelids to family level would appear to adequately distinguish the stations and groupings. Identification to this level results in a further saving in taxonomic effort; requiring only 31 identifications at Nubeena (13% of that required for the full assessment) and only 29 identifications at Meads Creek (16% of that required for the full assessment). Thus it should be possible to make benthic assessment a much more affordable proposition for farmers.

Chapter 5 – General Discussion

The two sites chosen for assessment in this study were very different and were specifically selected because they were believed to broadly represent the two main types of environmental condition under which salmon farming is conducted in Tasmania, i.e. sheltered and semi-exposed conditions.

Several studies have suggested that the effects of organic enrichment are site specific (Braaten et al., 1991; Holmer,1991, Woodward et al., 1992) and that certain environmental conditions are better adapted to cope with organic enrichment than others. Braaten et al. (1991) suggest that water flow is the most important factor in determining effect. It is well known that the sediment type is directly related to the depositional / suspension characteristics of the environment and therefore that coarser sediments may be better for farming (Rosenthal et al., 1988). Rosenthal et al. (1988) also suggested that there are two main types of sediment: depositional and erosional. Depositional sediments are characterised by fine particles and indicate areas with low water movement where detritus can accumulate; the sediments at the Meads Creek site fall within this category. Erosional sediments are coarser and indicate areas where there is active transport of fine particles; the Nubeena site would appear to fit this category. Lumb (1989) expanded these categories and characterised sites according to six different seabed groupings which, in turn, were indicative of the prevailing current characteristics. Woodward et al. (1992) also suggested that site specific differences occur with respect to their ability to endure environmental impacts and from the results of their study in the Huon estuary, Tasmania, they suggested that coastal areas were less well adapted than estuarine areas to increased organic enrichment levels.

Many methods have been used to assess the environmental impact of fish farming. Amongst the most widely used techniques are measurement of organic matter content, often as loss on ignition (LOI), determination of particulate carbon, nitrogen and phosphate levels, evaluation of the depth of the "fish farm sediment" or flocculent layer, measurement of sediment oxygenation, both directly and by measurement of redox potential, examination of the sediment water content, determination of sedimentation rate and assessment of benthic community structure. Measurement of the levels of nutrients in both the sediments and water column is

also often employed as a means to assess the environmental impact of cage farming. As the main focus of this study was on potential farm-based tools several of these methods were discarded either because they were too complex for incorporation into routine farm procedures or because they required specialist equipment for sampling or analysis. Consequently measurement of particulate carbon, nitrogen and phosphate, nutrient analysis and evaluation of sediment water content were discarded. After further careful assessment of the remaining physical / chemical techniques, described in Chapter 1, the parameters chosen for evaluation in this study were organic matter content (LOI), sediment oxygenation as indicated by redox potential of the sediment, and sedimentation rate.

Organic matter evaluation has been included in many of the investigations of the effects of organic enrichment (e.g. Pearson and Rosenberg, 1978; Brown et al., 1987; Moore and Rodger, 1991; Horwitz, P. and Blake, G., 1992: Johnsen et al., 1993; Johannessen et al, 1994; Wu et al., 1994; Karakassis et al., 1998; McGhie et al., in press) with varying degrees of success. The current study did not find organic matter levels to be a useful measure of farm effect. The levels bore no relationship to either species distribution or farm activity / inputs. In three of the aforementioned studies (Brown et al., 1987; Johannessen et al., 1994; Wu et al., 1994; Karakassis et al., 1998) organic matter was also found to have no clear relationship with farm effects whereas in all cases other methods of assessment, particularly the benthic fauna showed an impact.

Measurement of sedimentation could not be fully evaluated as the range of practical problems encountered with this particular technique, described in Chapter 2, showed it to be unsuitable for farm based application.

The two other main techniques assessed, redox potential and simple faunal characteristics, were both found to be useful. These techniques identified not just the presence of an environmental impact but also distinguished the degree of impact. Redox potential measurement, whether as a profile or at a particular depth was very good at identifying impact. Measurement of redox potential (Eh) levels can distinguish the boundary of the sulphide biome (Jorgensen and Fenchel, 1974), the point at which sediment conditions change from aerobic to anaerobic, and where negative Eh values are recorded. It is therefore possible to track the changes in the position of this layer through the sediment. Several studies have indicated Eh to be a

useful indicator of sediment condition (Brown et al., 1987; Hargrave et al., 1993, Cheshire et al., 1996; Karakassis et al., 1998). Hargrave et al. (1993) recommended the use of redox potential and sulphide measurement as the main parameters for evaluating the environmental impacts of the salmon farming industry in the Bay of Fundy. Similarly, Cheshire et al. (1996) in a study investigating the environmental impacts of the tuna cage farming industry in South Australia suggested that redox potential would be a useful parameter for measurement. In contrast Wu et al. (1994) was one of the few studies which found measurement of redox potential to be inconclusive. In this case all measures recorded were negative. However, Wu et al.'s study was quite different to both the present investigation and most of those already described, as it looked at the environmental effects of cage culture in a sub-tropical environment where a diet of trash fish was fed. Other parameters measured indicated that all the sample stations were severely impacted. Consequently the results of Wu et al.'s study are not directly comparable to the more advanced fish farming techniques associated with current salmonid aquaculture. It does however, highlight that measurement of redox potential must always be viewed in the appropriate context and preferably referenced to control conditions. The anoxic layer will naturally be shallower in finer sediments, the gradient of the redox profiles will be steeper and the likelihood of observing negative Eh values will be greater than in coarser sediments.

The spatial assessment also suggested that evaluation of simple faunal parameters such as total annelid abundance and total *Capitella capitata* complex numbers were useful indicators of variability in the extent of environmental disturbance. Both of these measures showed similar patterns of change to those identified through assessment of the full community structure, albeit with somewhat reduced precision. *Capitella capitata* complex has been identified in many studies as both an indicator of fish farm pollution (Brown et al.,1987; Weston,1990; Ye et al., 1991; Lim, 1991) and as an indicator of organic pollution generally (Pearson and Rosenberg, 1978; Tsutsumi, 1987). The distribution of *Capitella capitata* complex was shown by Cuomo (1985) to be strongly linked to the sulphide distribution, and therefore to the level of sediment degradation.

Diversity indices were not as successful as the simple faunal parameters in measurement of impact. The results obtained using the Shannon index were the most

comparable to full faunal assessment but, as had been previously shown by Brown et al. (1987), this technique only provides clear evidence of disturbance in areas directly beneath cages and at times when cages were fully stocked. These occasions could be distinguished equally clearly by the much simpler approach of *Capitella capitata* complex or annelid abundance measurement. Similarly, measurement of species richness and total faunal abundance were not found to be of value. These measures only identified the impacted cage stations and as such were no more effective than simple evaluation of *Capitella capitata* complex abundance. Drake and Arios (1997) assessed data from mono and polyculture lagoons using several univariate measures and found no differences between the systems whereas multivariate assessment showed very clear differences both between and within the lagoons. Moreover, diversity indices still have the fundamental problem that they require evaluation of the full benthic community with separation and enumeration of the fauna to species level. This is time consuming and requires a high level of taxonomic skill, which makes this approach unsuitable for farm-based assessment.

There have been many studies conducted on the spatial effects of impact within fish farms. The extent of the detectable impact found in these studies has been variable. Brown et al. (1987) found no impact beyond 25m from the cages; Gowen et al. (1988) found that there was no detectable effect beyond 30m whereas Weston (1990) could still detect an impact at a distance of 100m and Wu et al., 1994, under sub-tropical and less technologically advanced growing conditions, found impacts over much greater distances (1-1.5km). However, as Henderson and Ross (1995) pointed out investigations comparing impacts between different sites and different farm structures are rare. The present study has shown that there was a large degree of spatial variability within and between the two farms in relation to both the background conditions and the level of impact associated with cage farming operations. Level of impact is dependent on the prevailing environmental conditions and farm management circumstances and these circumstances will vary between sites and even between individual cages. The results of the hydrographical assessment of the two sites showed that they were very different with regard to both depth profile and sediment composition. The physical / chemical parameters assessed showed marked differences between the two sites and the baseline faunal composition at each site was also found to be quite different. However, these differences did not diminish

the ability of the techniques to distinguish change as a result of organic enrichment. When organic enrichment associated with cage operation occurred the patterns of change in both the fauna and in the physical / chemical characteristics between the two sites were remarkably similar. Henderson and Ross (1995) in a study examining data from 23 sites in Scotland, also found that, although the unimpacted faunal composition was very diverse, the grossly impacted faunal communities varied little between sites. The same pattern of change was described in association with aquaculture operations in the US by Weston (1990), in Canada by Hargrave et al. (1993), in the United Kingdom by Brown et al. (1987), in Scandinavia by Hansen (1990) and in south-east Asia by Ye et al. (1991). This pattern is equivalent to that described by Pearson and Rosenberg (1978) as a result of other sources of organic enrichment, such as sewage effluent, wood pulp mill effluent, oil spills and the by products from seaweed processing. In the present study it appeared that the effects of organic enrichment from fish farm waste overwhelmed any subtle changes which might be associated with natural background variation particularly with regard to the simple faunal assessments and redox. Multivariate community analysis was better able to detect differing levels of impact at each of the sites.

A fundamental step in any ecological investigation is the description of spatial patterns in the abundance of the organisms (Andrew and Mapstone, 1987). The benthic community structure represents a time-integrated response and therefore is a more reliable indicator of the long-term impact of organic pollution. Any changes in the physical and chemical characteristics of the sediments will lead to changes in the benthic community (Weston, 1990; Pocklington et al., 1994; Karakassis et al., 1998). Warwick and Clarke (1991) describe species dependent multivariate methods as being more sensitive than other biotic measures of environmental assessment in discriminating between different communities. Weston (1990) found that the fauna was sensitive to enrichment at levels undetectable with gross chemical measures and that faunal data better reflected cumulative environmental effects than did a single physical / chemical sampling event. Consequently, full macrofaunal assessment was identified as the most appropriate technique against which to judge the usefulness of all the other proposed methods. In the spatial study multivariate evaluation of the macrofauna clearly distinguished cage sites and discriminated between cage sites with regard to degree of impact. The spatial study showed clearly that there were

changing levels of impact within the leases at each of the farm sites. At Nubeena the community structure was quite clearly different and impacted at the cage stations but there was much less evidence of gradation at the adjacent stations than at Meads Creek. In the spatial survey at Meads Creek one cage station and one between cage station were clearly impacted however the fauna at these two stations was very different. *Capitella capitata* complex was only dominant at the cage station, suggesting that this was the more "polluted" location.

The macrofaunal distribution described for the temporal study at Nubeena indicated three distinct community groups. These groups correspond well to those described by Pearson and Rosenberg (1978) in relation to organic enrichment generally and to those described by Brown et al. (1987) in relation to fish farm effects. The fauna at the reference stations remained characteristically unimpacted with no major dominants. In contrast, the group 2 fauna was quite clearly impacted and dominated by *Capitella capitata* complex. This group could be further divided into two sub-groups which in turn were indicative of the extent and duration of impact and which correspond to the transitory and polluted categories described by Pearson and Rosenberg (1978). At Meads Creek the multivariate assessment of the fauna showed the distinction between the two main groups even more clearly than at Nubeena; there was markedly less gradation between the groups than at Nubeena. As previously indicated, the relatively high background levels of organic matter associated with the Huon / Channel systems (Huon Study Team, 2000) may have influenced the fauna at this site. It is possible that all stations were pre-adapted to a relatively high background level of organic enrichment. However, at those cage stations where fish were stocked the conditions were still clearly identifiable as impacted and the faunal structure was equivalent to that described by Pearson and Rosenberg (1978) as "polluted". The macrofaunal community assessment was sensitive to changes in the sediment condition, tracking cages in and out of the above groups in relation to their relative production status. It is interesting to note that "grossly polluted" conditions (Pearson and Rosenberg, 1978) were never encountered.

The ABC method for determination of environmental impact assessment, as proposed by Warwick (1986) and recommended by Ritz et al (1989) was generally found to agree with the outcomes of the multivariate assessment. Where these

techniques disagreed, multivariate assessment could be shown to be more accurate. The ABC method was determined not to be an appropriate technique for farm-based environmental monitoring as it required not just the identification and enumeration of the fauna but also recording of biomass data for all species groups within each sample.

There was some evidence of seasonal changes in the macrofaunal community structure at the reference stations, when fewer species and fewer individuals were recorded over the winter and spring period than in the summer. Several of the overseas studies on the effects of aquaculture have shown an apparent seasonal influence on the physical / chemical parameters (Brown et al., 1987; Holmer and Christensen, 1992; Hargrave et al., 1993) however, often these were shown to be as a result of seasonal patterns in the production cycle. (Holmer and Christensen, 1992; Cheshire et al., 1996; Gilbert et al., 1997; Karakassis et al., 1998). There was no evidence of seasonal changes in the cage associated stations, the production cycle and associated changes in organic enrichment were clearly the main influence on these stations. At the cage stations both the sediment community structure and the associated physical / chemical parameters alternated between unimpacted and impacted status in direct response to the fish size, stocking levels and duration of stocking. The impact levels revealed by both the faunal and physical / chemical parameters were clearly dependent on stocking levels and feed inputs and the duration of stocking. However, the length of time taken for recovery was not directly proportional to farming time, an effect already documented by Gowen et al. (1988). For example, if a cage site recovers within 3 weeks after a stocking period of 6 weeks it does not imply that a stocking period of 12 weeks will be associated with recovery within 6 weeks. The two sites were markedly different in the level of impact recorded and also in the degree to which the impact levels varied over time. At Nubeena there was a greater gradation of effect; at several sample times, only minor impact was indicated, however when exposed to prolonged farming the cage stations were found to be severely impacted. At Meads Creek there was a much clearer distinction between the impacted and unimpacted conditions. This may simply have been an artefact of sampling and it is possible that we missed the marginal conditions. Alternatively, the background conditions at this site may already have been pre-disposed to organic enrichment such that the addition of

further material had a proportionately greater impact. Movement of cage stations between the categories of impact indicated that recovery, as well as degradation, was occurring. It is interesting that the fastest recovery suggested by the benthic infaunal community structure was around 6-7 weeks at both sites. However, overall, the length of time required for recovery was more variable and once again appeared to be dependent on stocking levels and duration of stocking. It is interesting that the RPD depth measurements suggested that Meads Creek recovered more quickly than Nubeena. If we accept the theory that the Meads Creek site was naturally enriched then it might also be suggested that conditions did not have to recover to the same extent as at Nubeena. In this context, Rosenberg (1976) and Woodward et al. (1992) suggested that coastal areas were less well adapted for environmental impact than were estuarine areas.

All of the techniques evaluated were able to detect changes in the level of impact, however, some were clearly more successful than others. The results suggest that RPD measurement was a quick and fairly reliable measure of environmental impact, particularly if monitored regularly (fortnightly). Gowen et al., (1985), Brown et al., (1987), and Hargrave et al., (1993), in their studies on the organic enrichment effects of cage aquaculture, and Pearson and Stanley (1979), in their work on the effects of pulp mill effluent, all found some form of redox measurement to be a useful measure of sediment condition. Government monitoring programmes in both the Maritime provinces in Canada and in Scotland require measurement of redox potential as part of their standard environmental monitoring of aquaculture. A recent report to the Norwegian government assessing techniques for monitoring recommended redox potential measurement as one of the main parameters (Cochrane and Pearson, 1995). In Washington state (USA) the aquaculture monitoring programme requires evaluation of the RPD depth (Codling et al., 1995). The results of the present study suggest that RPD depth may be a more appropriate measure than surface redox potential as it was more stable and less prone to interference. In this regard Karakassis et al. (1998) also noted that surface measures may not provide adequate information on dynamic processes.

The majority of proposed regulatory monitoring programmes are structured with hierarchial levels of assessment and validation based on expected levels of impact. In the context of the present study it was felt that farm-based assessment should also

incorporate the option of alternative techniques for validation of impact levels. Thus, the results of the present study indicate that assessment of total capitellids may be a reliable technique which could be used as a quick alternative to full community assessment. Wildish et al. (1999) have produced a simple table relating changes in redox and sulphide levels to the four macrofaunal successional stages suggested by Pearson and Rosenberg (1978). Here that table (Figure 5.1) has been modified to incorporate some of the outcomes of the present study and it is clear that the levels of input identified at the two study sites correspond to three of the four groups described by Wildish et al. (1999).

Table 5.1: Comparison of descriptions of four categories of sediment condition by Poole et al. (1978), Lynch and Poole (1979), Pearson and Rosenberg (1978), Wildish et al. (in prep) and the present study.

Measurement	**Group**				**Reference**
Microbial	Normal	Oxic	Hypoxic	Anoxic	Poole et al , 1978
Geochemical		Aerobic	Denitrification	SO_4^{2-} Reduction	Lynch & Poole, 1979
Eh (mV)		>0	0 to -150	-150 to –200	Lynch & Poole, 1979
Macrofaunal	Normal	Transitory	Polluted	Grossly polluted	Pearson & Rosenberg, 1978
Geochemical	Oxic a	Oxic b	Hypoxic	Anoxic	Wildish et al , in prep
Eh (mV)	>+100	0-100	-100-0	<-100	Wildish et al , in prep
S^{2-} (μM)	<300	1300-300	6000-1300	>6000	Wildish et al., in prep
RPD depth level	>50mm	50-10mm	<10mm	NA	Present study
C capitata abund			>500/m^2	NA	Present study

(Modified from Wildish et al., 1999)

Evaluation of the benthic community structure at taxonomic levels above species did result in some loss of discrimination. The choice of taxonomic level will ultimately depend on the level of impact that it is necessary to discern and the resources available to undertake the assessments. Assessment at higher taxonomic level has been examined through several studies and it has been determined that patterns of spatial variation in response to pollution effects are similar for species and broader taxonomic categories (Warwick, 1988a, 1988b; Ferraro and Cole, 1990, 1992; Gray et al., 1990; Warwick et al., 1990). All of these assessments were primarily subjective visual comparisons of dendrograms or 2D ordinations. However, Somerfield and Clarke (1995) quantitatively compared data and, to some extent, substantiated previous findings. They found little loss of information with aggregation of macrofauna to family level. However, they did encounter problems at

phylum level and suggested that, ultimately, detection of community change at phylum level tells very little about the nature of the response to a pollution gradient and that in order to examine causality, it is necessary to have some knowledge of the fauna present and its ecology. The results of the present study suggest that assessment of the annelids alone was as effective as full community assessment and that there was no significant loss of resolution when this group was assessed at only family level. Ferraro and Cole (1990) also found that family level analysis was good for assessing pollution effects and had a high probability of detecting effect but they suggested that results were specific for particular sites and conditions and may not necessarily be true for all situations. Consequently it is recommended that the use of annelids at family level be further evaluated at several other leases before globally adopting this as an evaluation technique.

Gray et al (1988) found that in macrobenthic data from Sweden, the fauna was strongly dominated by three phyla (annelida, mollusca and echinodermata) and that under stressed conditions the annelids dominated both numerically and in terms of biomass. In the current study the annelids were also identified as the most dominant phylum when pollution was indicated. Interestingly Gray et al also found that the echinodermata were indicative of unpolluted conditions, which again is in agreement with the findings of the present study, where the absence of echinoderms was associated with markedly impacted conditions. Only the heart urchin, *Echinocardium cordatum*, was present in samples from sites diagnosed with moderate/minor impact whilst a range of echinoderm species and in particular the brittle star, *Amphiura elandiformis*, were associated with unimpacted conditions. However, it is advised that the reliability of this pattern be further assessed at several other sites before it can be globally adopted.

5.1 Conclusions & Recommendations

In summing up the outcomes of this study, it appears that, of the range of physical / chemical techniques assessed, redox potential measurement most closely reflected the conditions indicated by the full infaunal community assessment. Evaluation of the RPD depth was determined to be the simplest and most reliable farm-based means of measuring redox potential. It should be cautioned however, that it is not appropriate to use this parameter as a single absolute determinant of sediment

condition. It is important that the results should always be viewed in relation to other farm production information as part of a regular monitoring programme. It is recommended that at least two consecutive RPD level measurements at fortnightly intervals, which are indicative of unimpacted conditions, should be obtained before the sediment can be reliably considered to have recovered.

A quick count of total *Capitella capitata* complex numbers might be used to validate the RPD level measurements and consequently to categorise the sediment conditions as indicated in figure 5.1. However, it is important to note that absence of *Capitella capitata* complex may not indicate absence of impact. On the contrary, it may mean that the conditions have become so degraded that these opportunists have been inhibited. Consequently, this technique should also always be assessed in conjunction with reliable farm information to place the results in context.

In relation to conducting full benthic community surveys, the results of the taxonomic sufficiency component of this study certainly appear to indicate that it may be adequate to assess annelids to family level only in order to obtain an accurate representation of effect.

Finally, assessment of the echinoderm fauna looks very promising as a rapid evaluation technique for immediate appraisal of site condition.

5.2 Further Work / Research Extension

The results of the present study indicate the applicability of the techniques at both sites. However, it is advised that these techniques should be validated at other sites before fully relying on the recommendations. Validation would be particularly appropriate at sites where the environmental conditions vary markedly from those described.

The pattern of distribution found for the echinoderms was extremely interesting and appeared to suggest considerable potential as a simple assessment technique, but once again it is important to validate this finding at other sites.

An obvious extension of this research in relation to the redox potential measurements would be to develop an in-situ probe. This would make regular measurements of redox potential much easier.

One of the obvious limitations of this study was the scale of the temporal sampling. Bimonthly sampling made it difficult to clearly evaluate rates of degradation and recovery and the effects of varying farm production practices (stocking levels, feed input and duration of stocking) on these rates. A more detailed examination of these processes would allow better prediction of both recovery times and the factors influencing the recovery time.

Finally, the interesting temporal patterns shown in the mollusc community, (changing from bivalve to gastropod and native gastropod to introduced gastropod dominance) clearly warrants further examination. It would be extremely interesting to determine the processes driving these changes in the community and, from the farm management perspective, it may be important to determine whether these changes were independent of the farm conditions or if the farm influenced them.

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APPENDICES

APPENDICES 1

Appendix 1.1 : Number of individuals recorded from Nubeena samples.

		0-Cg1.a				0-Cg2.a					0-St3.a					0-St4 a					0-St5.a					0-St6 a					0-Ref.a			
Sp.Code	ScientificName	a	b	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	e
11001	Nephtys australiensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
11002	Eunice bassensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	1	0	1	0	0	0	1	2	0	5	0	0	0	0	0
11003	Glycera sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
11004	Glycera sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11005	Hesionid sp (MoV 2871)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
11006	Hesionidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11008	Hesione sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11010	Neanthes cricognatha	0	1	3	1	1	0	0	0	0	0	13	0	0	0	0	0	0	0	1	2	0	0	1	0	0	0	0	0	0	0	0	0	0
11011	Platynereis dumerilii antipoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
11013	Phyllodoce sp (MoV 511)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
11015	Lumbrinereis sp (MoV 322)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	7	2	4	11	2	0	0	0	0	0	0	0	0	0
11022	Simplisetia amphidonta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0
11023	Sthenelais pettibonae	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11024	Schistomeringos loveni	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	4	1	2	0	0	0	0	0	0	0	0	0
11025	Eusyllinae sp (MoV 3096)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11026	Epidiopatra sp (MoV 3095)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11027	Harmothoinae sp (MoV 2848)	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	1	0	2	0	0	0	3
11029	Dorvilleidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11036	Kinbergonuphis sp (MoV 327)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	4	0	0	0	0	0
11056	Syllidae sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
11058	Hesionidae sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
11070	Lumbrineridae sp 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11073	Pilargidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11074	Lumbrinereidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11076	Eunicidae sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13001	Prionospio kulin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
13002	Aricidea sp (MoV 903)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	2	0	0	0	2	0	0	0	0	0	0	0	2	0
13004	Spiophanes kroeyeri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13007	Euchone limnicola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	7	2	0	0	1	1	0	1	0	1	0	0	0	3
13011	Paraprionospio coora	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
13016	Diplocirrus sp (MoV 2626)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
13019	Aedicira sp (MoV 438)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
13021	Asychis sp 2 (13079)	4	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
13022	Malacoceros tripartitus	3	40	25	26	3	1	5	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
13023	Clymenella sp.1	0	0	0	0	0	0	0	0	0	0	0	0	5	4	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	1	0	1	0
13025	Asychis sp.1 (MoV 907)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13026	Capitella capitata complex	305	736	711	932	4	1	38	179	7	53	1	1	3	0	135	3	0	0	1	0	0	0	0	50	0	0	0	0	0	0	0	27	1
13027	Mediomastus australiensis	0	0	2	0	0	0	0	0	0	0	0	18	3	0	0	1	2	0	1	21	17	12	6	20	4	1	6	2	5	0	0	0	2
13029	Paraonides sp (MoV 1358)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
13030	Paraonidae sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13035	Magelonidae spp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
13036	Serpulidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0
13040	Phyllamphicteis sp (MoV 3094)	1	0	0	0	0	0	0	0	0	2	20	1	0	0	9	1	0	8	3	2	2	6	9	3	4	7	0	1	0	0	0	0	8
13042	Lysilla jennacubinae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13043	Artachamella dibranchiata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		0-Cg1.a				0-Cg2.a					0-St3.a					0-St4.a					0-St5.a					0-St6.a					0-Ref.a			
Sp.Code	ScientificName	a	b	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	e
13045	Eupolymnia koorangia	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13046	Maldanidae sp 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13047	Pista australis	0	0	0	0	1	0	0	0	2	1	0	1	1	2	2	5	16	5	5	42	99	70	124	111	10	8	4	5	5	0	0	7	3
13049	Aphelochaeta (Tharyx) sp (MoV 752)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13054	Aphelochaeta (Tharyx) sp (MoV 751)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13055	Chaetozone setosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13059	Leitoscoloplos bifurcatus	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13061	Leodamas ohlini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13065	Terebellides stroemii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
13069	Trichobranchidae sp 1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	21	0	12	7	1	0	1	0	0	1	0	1	1	0
13075	Pectinaria sp (MoV 636)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0
13076	Capitellidae sp 2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
13077	Ophelina sp (MoV 505)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
13079	Asychis sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13084	Armandia sp (MoV 282)	0	0	0	0	0	0	0	0	0	0	2	5	1	1	1	1	0	1	3	0	0	0	0	0	0	0	0	0	0	0	9	5	0
13109	Cirratulidae sp 9	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13120	Pseudopolydora pauchibranchiata	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
13121	Prionospio wambiri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13133	Maldanidae sp 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
13149	Ampharetidae sp (MoV 629)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13153	Spionidae sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13154	Maldanidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13156	Spionidae sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14000	Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20100	Zoea un-id	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21001	Lysianassidae sp 1	0	0	0	0	0	0	0	0	0	4	37	8	2	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21003	Birubius pannamunus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21004	Aora maculata	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21006	Liljeborgia dubia	0	0	0	0	0	0	0	0	0	2	0	2	0	1	0	0	1	1	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
21007	Paradexamine dandaloo	1	0	0	0	0	0	0	0	0	0	1	1	0	0	10	0	3	9	0	0	0	0	0	0	1	1	1	2	0	2	0	0	0
21008	Ischyrocerus sp 1	1	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21009	Corophium ascherusicum	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	1	0	6	0	1	0	0	0	0	0	0	0	0	0	6	0
21010	Birubius mayamayi	0	0	0	0	2	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
21011	Jassa marmorata	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21012	Birubius cartoo	1	1	1	11	0	0	1	0	0	9	5	10	8	30	0	6	1	0	2	0	0	1	0	1	0	4	2	1	4	3	5	6	1
21013	Brolgus tattersalli	0	0	0	0	0	0	0	0	0	0	0	49	0	0	4	11	40	16	3	1	0	0	0	0	9	0	5	8	1	0	0	4	0
21014	Birubius muldarpus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21015	Tiplmegus thalerus	0	0	0	0	0	0	0	0	0	0	0	1	3	3	6	2	0	0	5	2	0	1	0	0	0	0	0	0	0	0	0	0	0
21017	Birubius sp 3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21019	Phoxocephalus burleus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21020	Oedicerotidae sp	0	0	0	0	0	0	0	0	0	0	0	9	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	14	7	0
21022	Synadexamine runde	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21023	Ampeliscidae sp.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21026	Paradexamine dandaloo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0
21027	Jassa sp	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21028	Amarylis macrophalamus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
21031	Lysianassidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21036	Amelisca australis	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21045	Maera mastersi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
21046	Ceradocus rubromaculatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21047	Protolembos sp.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		0-Cg1.a				0-Cg2.a					0-St3 a					0-St4.a					0-St5.a					0-St6.a					0-Ref.a			
Sp.Code	ScientificName	a	b	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	e
21058	Tipimegus thalerus	0	0	0	0	0	0	0	0	0	6	0	0	0	0	3	1	10	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	1
21059	Ampelisca euroa	0	0	0	0	0	0	1	0	1	3	0	0	2	0	0	0	12	0	3	1	0	0	0	0	0	0	0	0	0	0	1	0	0
21065	Paradexamine thadalee	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21066	Tethygeneia sp (MoV 1304)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21073	Eusindae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
21074	Tiron sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21081	Byblis mildura	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21084	Aora maculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
21088	Photis sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	3	0	0	0	0	0	0	0	0	0	0	0	0
21096	Maera mastersi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21109	Ischyrocerus sp	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21110	Cheirphotis sp (cf MoV548)	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	2	7	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
21111	Aora sp (cf MoV588)	0	4	1	3	0	0	0	0	0	0	20	0	2	2	0	0	1	2	1	0	0	2	0	0	0	0	1	1	0	0	0	2	5
21112	Aoridae sp 3	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
21113	Booranus sp	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
21114	Booramus weemus	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	2	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
21115	Phoxocephalidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
21116	Birubius sp	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21117	Platyschnopidae sp 1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21119	Birubius gelarus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21120	Haustoridae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21121	Oedicerlidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21122	Amphipod sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
21123	Amphipod sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21124	Phoxocephalidae sp 7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	9	0	0	0	0	0	0	0	0	0	0	12	0	0	0
21127	Jassa sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21130	Liljeborgiidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21131	Amphipod sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21133	Birubius cf pannmunus	0	1	0	0	0	0	0	0	0	1	3	0	0	10	0	0	0	0	0	1	0	0	0	0	0	4	3	3	1	0	2	2	0
22003	Haliophasma cribense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22005	Natatolana woodjonesi	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	4	0	0	2	0	0	0	0	1	0	1	0	0	0	0	0	0
22006	Amakusanthura oleana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22013	Leptanthura flindersi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22023	Ispopoda sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22024	Gnathiidea sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22030	Anthuridea sp 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
23001	Parasterope sp (MoV 4)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23002	Euphilomedes sp (MoV 18)	0	0	1	1	2	0	0	0	0	8	3	77	9	76	0	0	1	0	3	5	3	2	3	2	0	0	0	0	0	2	19	47	0
23004	Euphilomedes sp (MoV 1021)	0	0	0	0	0	0	0	0	0	3	1	0	1	3	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	5	0
23006	Alternochelata sp (MoV 23)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23011	Cylindrolebendae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
23012	Cyprinodes sp (MoV 8)	0	0	0	0	0	0	0	0	0	0	2	0	3	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0
23015	Archasterope sp 1	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
23018	Ostracoda sp 20	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23019	Archasterope sp (MoV 1019)	0	0	0	0	0	0	0	0	0	4	9	0	4	6	1	0	1	1	0	7	0	6	3	0	0	1	0	0	0	5	8	9	0
24001	cf Apseudes sp 1 (Whiteleggia)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24002	Kalliapseudes sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	1	3	1	0	0	0	0	0	0	0	1	3	0	0	0	0
24004	Leptochelia dubia	0	0	0	2	2	0	1	0	0	1	1	0	0	0	0	0	0	1	1	2	0	2	2	5	0	5	2	13	1	0	0	0	4
24006	Apseudes sp 1 (Whiteleggia)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	2	0	0	0	0	0	0
24008	cf Apseudes sp 2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	7	5	0	0	0	0	0	0	0	0	12	0	0	0	0	1	0
24010	Leptochelia ignota	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0

		0-Cg1.a				0-Cg2.a					0-St3 a					0-St4.a					0-St5.a					0-St6.a					0-Ref.a			
Sp.Code	ScientificName	a	b	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	e
24012	Tanais sp	1	12	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25001	Callianassidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25002	Callianassa limosa	0	1	0	0	0	0	0	0	0	0	6	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
25004	Callianassa arenosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25006	Halicarcinus ovatus	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	3
25007	Notomithrax minor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25008	Hexapus granuliferus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25010	Cancer novaehollandiae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25016	Pagurixis handrecki	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	1	0	0	3	1	2	1	0	0	1	3	0	0	0	0	0
25017	Halicarcinus rostratus	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	6	0	1	2	0	0	0	0	0	0
25019	Upogebiidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25020	Litocheira bispinosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25023	Phlyxia intermedia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0
25024	Decapoda sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25027	Upogebia sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
25028	Pinnotheres hickmani	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25029	Hymensomatidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26002	Copepoda sp 2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27001	Dimorphostylis cottoni	0	0	0	0	0	0	0	0	0	3	1	23	3	32	1	0	4	1	1	5	0	0	2	0	1	0	0	3	0	1	10	16	0
27007	Cyclaspis caprella	0	0	0	0	1	0	0	0	0	1	1	34	5	16	0	0	2	0	1	1	0	0	0	0	0	0	0	0	0	2	26	26	0
27015	Leptocuma sp 1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0
27016	Cumacea sp 8	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27018	Cumacea sp 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29001	Caprella sp 1	0	3	1	1	1	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	4	0	1	2	1	1	0	0	0	0	0	0	1
29005	Nebalia longicornis	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0
29007	Shrimp sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29008	Leptochela sydniensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31002	Nassarius nigellus	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	1	0	0	1	16	0
31004	Maoncolpus roseus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0
31006	Polinices sp 2 (didymus)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31008	Polinices sp 2 (conicus)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0
31015	Scissurella atkinsoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
31020	Rissoellidae sp 1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0
31021	Dentimitrella taylorana	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31022	Fusinus novaehollandiae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
32001	Retusa cf pelyx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33002	Opistobranchia sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
33004	Opistobranchia sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33009	Opistobranchia sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33012	Opistobranchia sp 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
34001	Nucula pusilla	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34002	Mysella donaciformis	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34004	Mytilus edulis planulatus	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
34005	Nemocardium thetidis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
34009	Theora fragilis	0	0	0	1	0	0	0	0	0	0	1	1	0	0	1	0	2	0	1	5	6	7	4	3	0	1	1	1	1	0	0	0	0
34010	Hiatella australis	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
34011	Dosinia cf. circinana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
34012	Tellina margaritina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
34016	Venerupis anomala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34017	Fulvia tenuicostata	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	2	1	2	0	1	0	0	0	0	0	1	0	0	1	0	0
34021	Notocallista diemenensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

		0-Cg1.a				0-Cg2.a					0-St3.a					0-St4.a					0-St5.a					0-St6 a					0-Ref.a			
Sp.Code	ScientificName	a	b	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	e
34031	Amygdalum beddomei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34032	Bassina disjecta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34043	Irus carditoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34045	Irus gnseus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34050	Bivalve sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37006	Chiton sp 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42003	Patenella regularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
42004	Asteroidea sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43001	Amphiura elandiformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	2	0	0	0	0	0	0
43004	Ophuroid sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43005	Ophuroid sp.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43008	Ophiuroid sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43009	Ophuroid sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44001	Echinocardium cordatum	0	3	0	3	0	0	0	0	1	2	3	1	0	6	2	0	0	3	0	0	2	0	1	0	2	0	0	0	0	2	0	0	3
44005	Temnopleurus sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45004	Holothuroidea sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0
45006	Holothuroidea sp 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52001	Anenome sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0	0	0	0	0
52002	Anenome sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
52006	Anenome sp 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61001	Platyhelminthes sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
62000	Nemertea un-id	0	0	0	0	0	0	0	0	0	1	0	2	0	1	0	0	0	1	0	3	2	2	0	1	0	0	0	0	0	0	0	7	0
63000	Nematoda un-id	0	2	0	34	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
81002	Sipunculan sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
81003	Sipunculan sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81004	Sipuncula sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91001	Ascidea sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91002	Ascidea sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91003	Ascidea sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94002	Fish sp 2 (weed fish)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94004	Pisces sp.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96001	Phoronida sp 1	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1
96004	Phoronida sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	1	0	0	0	0	0	1

APPENDICES 1

Appendix 1.1 (Cont.) : Number of individuals recorded from Nubeena samples.

		0-St8.a					0-St9.a					2-Ref.a					2-Cg2.a					2-Cg1.a					4-Ref.c			4-Cg2.a				
Sp.Code	ScientIfIcName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	c	d	e	a	b	c	d	e
11001	Nephtys australiensis	0	0	0	0	0	3	2	5	5	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11002	Eunice bassensis	0	0	0	0	1	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	4	0	0	0	1
11003	Glycera sp 1	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	2	1	0
11004	Glycera sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11005	Hesionid sp (MoV 2871)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11006	Hesionidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11008	Hesione sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11010	Neanthes oncognatha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	3	0	3	0	2
11011	Platynereis dumerilii antipoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11013	Phyllodoce sp (MoV 511)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
11015	Lumbrinereis sp (MoV 322)	0	0	2	0	0	5	3	3	4	5	1	3	2	3	3	1	0	2	2	3	0	0	0	0	0	4	4	1	2	3	0	2	3
11022	Simplisetia amphidonta	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
11023	Sthenelais pettibonae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11024	Schistomeringos loveni	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
11025	Eusyllinae sp (MoV 3096)	0	0	0	0	0	0	0	0	0	0	2	8	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0
11026	Epidiopatra sp.(MoV 3095)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11027	Harmothoinae sp (MoV 2848)	2	2	0	1	0	0	0	2	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11029	Dorvilleidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11036	Kinbergonuphis sp (MoV 327)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11056	Syllidae sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11058	Hesionidae sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11070	Lumbrinendae sp 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11073	Pilargidae sp 2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11074	Lumbrinereidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11076	Eunicidae sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13001	Prionospio kulin	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	1	2	1	0	0	0	0	0	2	1	0	2	0	0	0	0
13002	Ancidea sp (MoV 903)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13004	Spiophanes kroeyeri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13007	Euchone limnicola	1	5	1	3	0	6	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
13011	Paraprionospio coora	0	0	0	0	0	1	5	0	0	2	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13016	Diplocirrus sp (MoV 2626)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13019	Aedicira sp (MoV 438)	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13021	Asychis sp 2 (13079)	0	0	2	0	0	12	0	0	9	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13022	Malacoceros tripartitus	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	28	31	5	7	4	0	0	0	4	0	2	0	0
13023	Clymenella sp 1	0	0	0	0	0	1	22	0	0	16	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13025	Asychis sp.1 (MoV 907)	0	2	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13026	Capitella capitata complex	4	0	0	0	0	0	1	0	0	1	0	0	2	3	0	0	0	3	0	0	294	178	232	215	100	0	0	0	51	18	27	46	46
13027	Mediomastus australiensis	3	17	5	3	4	0	0	0	2	1	12	78	32	23	36	13	0	17	8	9	0	0	1	0	0	8	15	16	6	0	1	2	0
13029	Paraonides sp (MoV 1358)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13030	Paraonidae sp 3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13035	Magelonidae spp	0	0	0	0	0	0	0	0	0	0	3	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13036	Serpulidae sp 1	0	0	0	0	0	0	3	0	0	0	0	2	0	4	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13040	Phyllamphicteis sp (MoV 3094)	0	50	16	4	26	14	23	8	16	33	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13042	Lysilla jennacubinae	0	1	4	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0
13043	Artachamella dibranchiata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		0-St8 a					0-St9.a					2-Ref.a					2-Cg2.a					2-Cg1.a					4-Ref.c			4-Cg2 a				
Sp.Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	c	d	e	a	b	c	d	e
13045	Eupolymnia koorangia	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
13046	Maldanidae sp 6	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13047	Pista australis	22	34	11	17	16	20	0	22	11	5	17	23	33	20	17	17	0	7	3	3	0	0	0	0	0	9	3	24	2	0	0	1	0
13049	Aphelochaeta (Tharyx) sp.(MoV 752)	0	0	0	0	1	6	1	0	1	7	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0
13054	Aphelochaeta (Tharyx) sp (MoV 751)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0
13055	Chaetozone setosa	0	0	0	0	0	0	2	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13059	Leitoscoloplos bifurcatus	0	0	0	0	0	1	4	1	1	2	1	1	1	1	0	1	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13061	Leodamas chilni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13065	Terebellides stroemii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
13069	Trichobranchidae sp 1	0	0	0	1	2	9	8	5	4	12	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13075	Pectinaria sp.(MoV 636)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13076	Capitellidae sp 2	0	0	0	2	0	0	0	0	0	0	0	8	2	0	4	1	0	0	0	0	0	0	0	0	0	1	2	1	2	2	0	0	2
13077	Ophelina sp (MoV 505)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13079	Asychis sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13084	Armandia sp (MoV 282)	5	3	5	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13109	Cirratulidae sp.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13120	Pseudopolydora pauchibranchiata	0	0	0	0	0	31	23	0	11	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13121	Prionospio wambin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13133	Maldanidae sp 10	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2
13149	Ampharetidae sp (MoV 629)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13153	Spionidae sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	6	0	0	0	0
13154	Maldanidae sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13156	Spionidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	1	1	0	2	0	0	6
14000	Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20100	Zoea un-id	0	1	0	0	0	1	1	0	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21001	Lysianassidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	4	3	0	0	0	0	0	1	1	0	10	3	0	0	1
21003	Birubius pannamunus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21004	Aora maculata	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	7	0	0	0	0
21006	Liljeborgia dubia	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21007	Paradexamine dandaloo	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21008	Ischyrocerus sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21009	Corophium ascherusicum	2	11	1	0	3	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	1
21010	Birubius mayamayi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	1	0	0	0	0	0
21011	Jassa marmorata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
21012	Birubius cartoo	1	7	0	0	2	0	0	0	0	0	0	4	2	2	3	1	0	0	2	4	0	0	0	0	0	2	1	2	2	2	6	1	1
21013	Brolgus tattersalli	2	0	0	1	0	0	0	0	0	0	0	12	5	9	8	0	0	3	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0
21014	Birubius muldarpus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21015	Tiparegus thalerus	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
21017	Birubius sp 3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21019	Phoxocephalus burleus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21020	Oedicerotidae sp	0	1	0	0	3	2	0	0	2	0	0	0	0	2	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21022	Synadexamine runde	0	8	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21023	Ampeliscidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
21026	Paradexamine dandaloo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21027	Jassa sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21028	Amarylis macrophalamus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21031	Lysianassidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21036	Amelisca australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
21045	Maera mastersi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21046	Ceradocus rubromaculatus	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21047	Protolembos sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		0-St8.a					0-St9.a					2-Ref.a					2-Cg2.a					2-Cg1 a					4-Ref.c			4-Cg2 a				
Sp.Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	c	d	e	a	b	c	d	e
21058	Tipimegus thalerus	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21059	Ampelisca euroa	0	2	0	0	2	1	3	1	0	5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
21065	Paradexamine thadalee	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21066	Tethygeneia sp (MoV 1304)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21073	Eusindae sp.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
21074	Tiron sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
21081	Byblis mildura	0	0	0	0	3	1	3	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21084	Aora maculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21088	Photis sp	0	0	0	0	0	2	2	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21096	Maera mastersi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21109	Ischyrocerus sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0	0	0	0	0	0	0	0
21110	Cheirphotis sp (cf MoV548)	0	5	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21111	Aora sp (cf MoV588)	7	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21112	Aoridae sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21113	Booranus sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21114	Booramus weemus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
21115	Phoxocephalidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21116	Birubius sp	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21117	Platyischnopidae sp 1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21119	Birubius gelarus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	1	0	0	1	0	0	0	0
21120	Haustoridae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21121	Oedicerotidae sp	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21122	Amphipod sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21123	Amphipod sp	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21124	Phoxocephalidae sp 7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21127	Jassa sp	7	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
21130	Liljeborgiidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21131	Amphipod sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21133	Birubius cf pannmunus	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22003	Haliophasma cribense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22005	Natatolana woodjonesi	0	0	0	0	0	4	7	0	1	7	0	0	0	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22006	Amakusanthura olearia	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
22013	Leptanthura flindersi	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
22023	Ispopoda sp 2	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22024	Gnathiidea sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22030	Anthuridea sp 15	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23001	Parasterope sp (MoV 4)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	12	0	1	0	0	0	0	1	1	1	2	3	3	4
23002	Euphilomedes sp (MoV 18)	0	0	0	1	1	9	11	0	4	11	0	0	0	0	0	23	0	4	17	11	0	0	0	0	0	0	0	0	2	0	0	0	0
23004	Euphilomedes sp (MoV 1021)	0	0	0	0	0	0	12	0	6	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23006	Alternochelata sp (MoV 23)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23011	Cylindroleberidae sp 2	0	0	1	0	0	2	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23012	Cyprinodes sp (MoV 8)	0	3	2	0	9	1	4	0	1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23015	Archasterope sp 1	0	1	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23018	Ostracoda sp 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23019	Archasterope sp (MoV 1019)	0	0	1	1	1	0	6	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24001	cf Apseudes sp 1 (Whiteleggia)	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	3	0	0	0	0	0
24002	Kalliapseudes sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
24004	Leptochelia dubia	0	1	16	1	0	1	0	0	0	0	0	9	1	1	1	0	0	3	0	0	6	8	1	1	0	1	1	0	12	1	0	0	1
24006	Apseudes sp.1 (Whiteleggia)	0	0	0	0	0	0	0	0	0	0	3	11	9	0	4	0	0	8	0	0	0	0	0	0	0	0	8	3	2	0	0	0	0
24008	cf Apseudes sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24010	Leptochelia ignota	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		0-St8.a					0-St9.a					2-Ref.a					2-Cg2 a					2-Cg1.a					4-Ref.c			4-Cg2.a				
Sp.Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	c	d	e	a	b	c	d	e
24012	Tanais sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25001	Callianassidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25002	Callianassa limosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
25004	Callianassa arenosa	0	0	0	0	0	4	3	0	4	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
25006	Halicarcinus ovatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
25007	Notomithrax minor	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25008	Hexapus granuliferus	0	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25010	Cancer novaehollandiae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25016	Pagurixis handrecki	1	8	2	0	1	0	0	0	0	0	1	0	1	3	7	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0
25017	Halicarcinus rostratus	0	1	0	0	0	0	2	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25019	Upogebiidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25020	Litocheira bispinosa	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25023	Phlyxia intermedia	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
25024	Decapoda sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25027	Upogebia sp 2	0	2	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25028	Pinnotheres hickmani	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25029	Hymensomatidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
26002	Copepoda sp 2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27001	Dimorphostylis cottoni	0	9	2	2	6	10	10	1	6	14	0	0	0	0	0	1	0	3	6	3	0	0	0	0	0	1	1	1	0	0	0	0	0
27007	Cyclaspis caprella	0	2	4	0	3	0	2	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27015	Leptocuma sp 1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27016	Cumacea sp 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27018	Cumacea sp 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29001	Caprella sp 1	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0
29005	Nebalia longicornis	2	0	0	0	0	0	0	0	0	0	12	3	1	0	2	0	0	0	0	0	3	5	0	1	0	0	0	0	0	0	0	0	0
29007	Shrimp sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29008	Leptochela sydniensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31002	Nassarius nigellus	0	0	0	0	0	1	4	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
31004	Maoricolpus roseus	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31006	Polinices sp 2 (didymus)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31008	Polinices sp 2 (conicus)	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
31015	Scissurella atkinsoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31020	Rissoellidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31021	Dentimitrella taylorana	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31022	Fusinus novaehollandiae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32001	Retusa cf. pelyx	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33002	Opistobranchia sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33004	Opistobranchia sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
33009	Opistobranchia sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33012	Opistobranchia sp 12	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34001	Nucula pusilla	0	0	0	0	0	1	1	0	0	2	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34002	Mysella donaciformis	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34004	Mytilus edulis planulatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
34005	Nemocardium thetidis	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34009	Theora fragilis	0	2	0	0	0	25	34	0	0	0	3	1	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34010	Hiatella australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34011	Dosinia cf circinana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34012	Tellina margaritina	0	0	0	0	0	0	0	0	6	28	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34016	Venerupis anomala	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34017	Fulvia tenuicostata	3	2	1	1	0	0	2	0	0	2	0	0	0	2	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1
34021	Notocallista diemenensis	0	2	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Sp.Code	ScientificName	0-St8.a					0-St9 a					2-Ref.a					2-Cg2.a					2-Cg1.a					4-Ref.c			4-Cg2.a				
		a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	c	d	e	a	b	c	d	e
34031	Amygdalum beddomei	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34032	Bassina disjecta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34043	Irus carditoides	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34045	Irus gnseus	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34050	Bivalve sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37006	Chiton sp 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42003	Patenella regularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
42004	Asteroidea sp.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43001	Amphiura elandiformis	0	0	0	0	0	5	0	0	0	2	2	3	1	1	2	1	0	1	0	0	0	0	0	0	0	3	1	2	1	0	0	0	0
43004	Ophuroid sp 4	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43005	Ophuroid sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43008	Ophiuroid sp	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43009	Ophuroid sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44001	Echinocardium cordatum	3	5	0	2	1	6	2	2	1	3	0	0	0	0	0	5	1	1	2	2	0	0	0	0	0	0	0	0	3	2	1	0	3
44005	Temnopleurus sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45004	Holothuroidea sp 4	0	0	0	2	0	0	0	0	0	0	1	3	1	5	0	0	0	1	0	2	0	0	0	0	0	1	0	0	1	0	0	0	0
45006	Holothuroidea sp 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52001	Anenome sp.1	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
52002	Anenome sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52006	Anenome sp 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61001	Platyhelminthes sp 2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62000	Nemertea un-id	1	1	1	0	0	2	5	1	1	3	0	0	2	1	1	3	2	1	2	2	0	0	0	0	0	1	1	1	2	1	0	0	0
63000	Nematoda un-id	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
81002	Sipunculan sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81003	Sipunculan sp 3	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81004	Sipuncula sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91001	Ascidea sp.1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91002	Ascidea sp.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91003	Ascidea sp 3	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94002	Fish sp 2 (weed fish)	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94004	Pisces sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96001	Phoronida sp 1	0	0	0	0	0	4	7	4	1	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	1	0
96004	Phoronida sp 4	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDICES 1

Appendix 1.1 (Cont.) : Number of individuals recorded from Nubeena samples.

		4-Cg1 a					6-Ref.a					6-Cg2.a					6-Cg1.a					8-Ref a					9-Ref.a					9-Cg2.a		
Sp.Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	d
11001	Nephtys australiensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11002	Eunice bassensis	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1
11003	Glycera sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
11004	Glycera sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11005	Hesionid sp (MoV 2871)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
11006	Hesionidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11008	Hesione sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11010	Neanthes cricognatha	3	15	8	12	6	1	0	0	0	0	4	7	14	10	9	10	9	5	9	7	0	0	0	0	0	0	0	0	0	0	1	0	0
11011	Platynereis dumerilii antipoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11013	Phyllodoce sp (MoV 511)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11015	Lumbrineris sp (MoV 322)	0	0	0	0	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	1
11022	Simplisetia amphidonta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11023	Sthenelais pettibonae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
11024	Schistomeringos loveni	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11025	Eusyllinae sp (MoV 3096)	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11026	Epidiopatra sp (MoV 3095)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	2	0	0	0	1	0	0	0	0
11027	Harmothoinae sp (MoV 2848)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11029	Dorvilleidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11036	Kinbergonuphis sp (MoV 327)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11056	Syllidae sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11058	Hesionidae sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11070	Lumbrinendae sp 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
11073	Pilargidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11074	Lumbrinereidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11076	Eunicidae sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13001	Prionospio kulin	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
13002	Ancidea sp (MoV 903)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13004	Spiophanes kroeyeri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13007	Euchone limnicola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	1	0	0	0	0	0	0	0
13011	Paraprionospio coora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13016	Diplocirrus sp (MoV 2626)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13019	Aedicira sp (MoV 438)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13021	Asychis sp 2 (13079)	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13022	Malacoceros tripartitus	2	8	4	8	16	0	0	0	0	0	2	0	1	3	3	1	1	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
13023	Clymenella sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13025	Asychis sp 1 (MoV 907)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13026	Capitella capitata complex	49	130	109	88	249	0	0	0	0	0	12	6	12	28	16	28	94	14	48	101	0	0	0	0	0	0	0	0	0	0	0	0	0
13027	Mediomastus australiensis	0	0	0	0	0	3	18	9	19	8	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	7	0	14
13029	Paraonides sp (MoV 1358)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13030	Paraonidae sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13035	Magelonidae spp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13036	Serpulidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13040	Phyllamphicteis sp (MoV 3094)	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	3	2	6	3	1	1	1	0	4	0	0	0	0
13042	Lysilla jennacubinae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	5	0	2	1	0	0	0	0
13043	Artachamella dibranchiata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	2	1	0	0	0	0	0

		4-Cg1.a					6-Ref.a					6-Cg2 a					6-Cg1.a					8-Ref.a					9-Ref a					9-Cg2.a		
Sp.Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	d
13045	Eupolymnia koorangia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13046	Maldanidae sp 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13047	Pista australis	0	0	1	0	0	5	6	11	6	3	0	0	0	0	0	0	0	0	0	0	2	9	3	5	6	3	5	1	2	2	5	0	0
13049	Aphelochaeta (Tharyx) sp.(MoV 752)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13054	Aphelochaeta (Tharyx) sp (MoV 751)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
13055	Chaetozone setosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13059	Leitoscoloplos bifurcatus	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13061	Leodamas ohlini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
13065	Terebellides stroemii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
13069	Trichobranchidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13075	Pectinaria sp (MoV 636)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13076	Capitellidae sp 2	0	0	0	0	0	0	1	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	0	0	0	4	3
13077	Ophelina sp (MoV 505)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13079	Asychis sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13084	Armandia sp (MoV 282)	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13109	Cirratulidae sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13120	Pseudopolydora pauchibranchiata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13121	Prionospio wambiri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13133	Maldanidae sp 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13149	Ampharetidae sp (MoV 629)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
13153	Spionidae sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
13154	Maldanidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13156	Spionidae sp	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
14000	Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20100	Zoea un-id	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21001	Lysianassidae sp 1	0	1	3	0	1	0	0	0	0	0	0	0	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
21003	Birubius pannamunus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21004	Aora maculata	7	12	8	2	18	0	0	0	0	0	8	1	15	20	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21006	Liljeborgia dubia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21007	Paradexamine dandaloo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21008	Ischyrocerus sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21009	Corophium ascherusicum	0	1	0	0	0	0	0	0	0	0	1	1	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21010	Birubius mayamayi	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
21011	Jassa marmorata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21012	Birubius cartoo	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1
21013	Brolgus tattersalli	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2
21014	Birubius muldarpus	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
21015	Tipimegus thalerus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	1	2	1	0	0	0	0
21017	Birubius sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	0	0	0	0
21019	Phoxocephalus burleus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21020	Oedicerotidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
21022	Synadexamine runde	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21023	Ampeliscidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21026	Paradexamine dandaloo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21027	Jassa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21028	Amarylis macrophalamus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21031	Lysianassidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21036	Amelisca australis	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
21045	Maera mastersi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21046	Ceradocus rubromaculatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21047	Protolembos sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		4-Cg1.a					6-Ref.a					6-Cg2 a					6-Cg1.a					8-Ref a					9-Ref.a					9-Cg2.a		
Sp.Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	d
21058	Tipimegus thalerus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21059	Ampelisca euroa	0	0	0	0	0	0	0	2	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0	0	0	0
21065	Paradexamine thadalee	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21066	Tethygeneia sp (MoV 1304)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21073	Eusindae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21074	Tiron sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21081	Byblis mildura	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21084	Aora maculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21088	Photis sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21096	Maera mastersi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
21109	Ischyrocerus sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21110	Cheimphotis sp (cf MoV548)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21111	Aora sp (cf MoV588)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21112	Aoridae sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21113	Booranus sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21114	Booramus weemus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21115	Phoxocephalidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21116	Birubius sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21117	Platyschnopidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21119	Birubius gelarus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
21120	Haustoridae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
21121	Oedicerlidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21122	Amphipod sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21123	Amphipod sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21124	Phoxocephalidae sp 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21127	Jassa sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21130	Liljeborgiidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21131	Amphipod sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21133	Birubius cf pannmunus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
22003	Haliophasma cribense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22005	Natatolana woodjonesi	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
22006	Amakusanthura oleana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22013	Leptanthura flindersi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22023	Ispopoda sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22024	Gnathiidea sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22030	Anthuridea sp.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23001	Parasterope sp (MoV 4)	0	0	1	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
23002	Euphilomedes sp (MoV 18)	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
23004	Euphilomedes sp (MoV 1021)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23006	Alternochelata sp (MoV 23)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23011	Cylindrolebendae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23012	Cypridinodes sp (MoV 8)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23015	Archasterope sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23018	Ostracoda sp 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0
23019	Archasterope sp (MoV 1019)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24001	cf Apseudes sp 1 (Whiteleggia)	0	0	0	1	0	0	2	5	6	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24002	Kallrapseudes sp 1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0
24004	Leptochelia dubia	0	1	0	0	0	0	1	1	1	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24006	Apseudes sp 1 (Whiteleggia)	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
24008	cf Apseudes sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24010	Leptochelia ignota	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		4-Cg1 a					6-Ref.a					6-Cg2.a					6-Cg1.a					8-Ref.a					9-Ref.a					9-Cg2.a		
Sp.Code	SclentlfIcName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	d
24012	Tanais sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25001	Callianassidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25002	Callianassa limosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25004	Callianassa arenosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25006	Halicarcinus ovatus	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25007	Notomithrax minor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25008	Hexapus granuliferus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25010	Cancer novaehollandiae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25016	Pagurixis handrecki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
25017	Halicarcinus rostratus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25019	Upogebiidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25020	Litocheira bispinosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25023	Phlyxia intermedia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25024	Decapoda sp.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25027	Upogebia sp 2	0	0	1	0	0	2	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25028	Pinnotheres hickmani	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25029	Hymensomatidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26002	Copepoda sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27001	Dimorphostylis cottoni	0	1	1	0	1	0	0	0	0	0	1	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27007	Cyclaspis caprella	1	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27015	Leptocuma sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27016	Cumacea sp 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27018	Cumacea sp 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
29001	Caprella sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29005	Nebalia longicornis	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29007	Shrimp sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29008	Leptochela sydniensis	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31002	Nassarius nigellus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31004	Maoricolpus roseus	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31006	Polinices sp 2 (didymus)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31008	Polinices sp 2 (conicus)	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
31015	Scissurella atkinsoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31020	Rissoellidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31021	Dentimitrella taylorana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31022	Fusinus novaehollandiae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32001	Retusa cf. pelyx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33002	Opistobranchia sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33004	Opistobranchia sp 4	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33009	Opistobranchia sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33012	Opistobranchia sp 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34001	Nucula pusilla	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34002	Mysella donaciformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34004	Mytilus edulis planulatus	6	0	3	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34005	Nemocardium thetidis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34009	Theora fragilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34010	Hiatella australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34011	Dosinia cf circinana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34012	Tellina margantina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34016	Venerupis anomala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34017	Fulvia tenuicostata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34021	Notocallista diemenensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		4-Cg1.a					6-Ref.a					6-Cg2.a					6-Cg1.a					8-Ref.a					9-Ref.a					9-Cg2.a		
Sp.Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	d
34031	Amygdalum beddomei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34032	Bassina disjecta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34043	Irus carditoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34045	Irus gnseus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34050	Bivalve sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37006	Chiton sp 6	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42003	Patenella regularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42004	Asteroidea sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43001	Amphiura elandiformis	1	0	0	0	0	0	2	1	1	1	0	0	0	0	0	0	0	0	0	0	1	2	0	1	1	0	1	1	1	1	1	0	1
43004	Ophuroid sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43005	Ophuroid sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
43008	Ophiuroid sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
43009	Ophuroid sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
44001	Echinocardium cordatum	1	0	0	0	0	0	0	3	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	0	0	2	2	2
44005	Temnopleurus sp.	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45004	Holothuroidea sp 4	1	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0
45006	Holothuroidea sp 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52001	Anenome sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	1	0	0	0	0
52002	Anenome sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52006	Anenome sp 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
61001	Platyhelminthes sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62000	Nemertea un-id	1	0	0	0	0	0	1	0	0	0	0	0	0	2	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
63000	Nematoda un-id	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81002	Sipunculan sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81003	Sipunculan sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81004	Sipuncula sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91001	Ascidea sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91002	Ascidea sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91003	Ascidea sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94002	Fish sp 2 (weed fish)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94004	Pisces sp.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96001	Phoronida sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96004	Phoronida sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDICES 1

Appendix 1.1 (Cont.) : Number of individuals recorded from Nubeena samples.

		9-Cg1.a					11-Ref.a					11-Cg2 a					13-Ref.a					13-Cg2 a					15-Ref a				15-Cg2.a				
Sp.Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	c	d	e	a	b	c	d	e
11001	Nephtys australiensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
11002	Eunice bassensis	0	0	0	0	0	0	1	1	1	2	1	0	1	0	0	0	0	0	0	0	1	0	0	1	1	0	1	1	0	0	0	0	0	0
11003	Glycera sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0
11004	Glycera sp 2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11005	Hesionid sp (MoV 2871)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2
11006	Hesionidae sp.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11008	Hesione sp 2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11010	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0	4	1	1	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	16	24	11	49
11011	Platynereis dumerilii antipoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11013	Phyllodoce sp (MoV 511)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	2	1	0
11015	Lumbrinereis sp (MoV 322)	1	0	0	0	1	2	1	3	0	1	1	1	1	4	2	1	0	1	2	0	1	2	0	0	2	0	0	7	1	0	0	1	0	0
11022	Simplisetia amphidonta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11023	Sthenelais pettibonae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
11024	Schistomeringos loveni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11025	Eusyllinae sp.(MoV 3096)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	3	1	7	0	3	5	3	0
11026	Epidiopatra sp (MoV 3095)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
11027	Harmothoinae sp (MoV 2848)	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
11029	Dorvilleidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11036	Kinbergonuphis sp.(MoV 327)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
11056	Syllidae sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11058	Hesionidae sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11070	Lumbrinendae sp 8	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11073	Pilargidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11074	Lumbrinereidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11076	Eunicidae sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13001	Prionospio kulin	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
13002	Anicidea sp (MoV 903)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13004	Spiophanes kroeyeri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13007	Euchone limnicola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13011	Paraprionospio coora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
13016	Diplocirrus sp (MoV 2626)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13019	Aedicira sp (MoV 438)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13021	Asychis sp 2 (13079)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13022	Malacoceros tripartitus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	1	13	1	54
13023	Clymenella sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
13025	Asychis sp 1 (MoV 907)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
13026	Capitella capitata complex	0	0	0	0	0	0	0	0	0	1	20	15	28	2	2	0	0	0	0	0	0	0	0	0	0	13	0	0	0	442	526	322	416	407
13027	Mediomastus australiensis	4	6	5	6	8	0	3	6	2	10	4	1	1	7	5	12	7	4	4	8	6	19	23	2	19	38	20	35	31	8	2	15	4	1
13029	Paraonides sp (MoV 1358)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13030	Paraonidae sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13035	Magelonidae spp	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
13036	Serpulidae sp.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13040	Phyllamphicteis sp (MoV 3094)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	1	1	0	0	1	0	0	0	0	0	0	0
13042	Lysilla jennacubinae	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
13043	Artacamella dibranchiata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		9-Cg1.a					11-Ref a					11-Cg2.a					13-Ref a					13-Cg2.a					15-Ref.a				15-Cg2 a				
Sp.Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	c	d	e	a	b	c	d	e
13045	Eupolymnia koorangia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
13046	Maldanidae sp 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
13047	Pista australis	8	1	8	4	4	6	3	6	2	12	2	0	3	6	4	15	1	3	2	4	10	23	26	11	12	14	39	38	20	0	1	0	0	0
13049	Aphelochaeta (Tharyx) sp (MoV 752)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0
13054	Aphelochaeta (Tharyx) sp (MoV 751)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0
13055	Chaetozone setosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0
13059	Leitoscoloplos bifurcatus	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	1	1	2	0	0	0	0	0	0
13061	Leodamas ohlini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13065	Terebellides stroemii	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13069	Trichobranchidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13075	Pectinaria sp (MoV 636)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	0
13076	Capitellidae sp 2	0	0	0	0	1	0	1	2	0	0	2	1	2	0	0	1	0	3	0	2	1	1	1	0	0	0	0	3	0	0	0	0	0	0
13077	Ophelina sp (MoV 505)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13079	Asychis sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13084	Armandia sp (MoV 282)	0	0	0	0	0	1	0	0	0	0	1	2	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	2	0	0	0	0	1	0
13109	Cirratulidae sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13120	Pseudopolydora pauchibranchiata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	5	0	0	0
13121	Prionospio warnbin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	2	0	0	0	0	0
13133	Maldanidae sp 10	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13149	Ampharetidae sp (MoV 629)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13153	Spionidae sp 9	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	1
13154	Maldanidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13156	Spionidae sp	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14000	Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	0	0
20100	Zoea un-id	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21001	Lysianassidae sp 1	1	0	0	0	0	0	0	0	1	0	1	2	3	0	1	2	2	0	0	1	2	1	4	0	0	0	1	0	1	1	1	1	0	1
21003	Birubius pannamunus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0
21004	Aora maculata	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2	1	1	0	1	5	2	3	3	0
21006	Liljeborgia dubia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
21007	Paradexamine dandaloo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21008	Ischyrocerus sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21009	Corophium acherusicum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	18	6	8	14
21010	Birubius mayarnayi	1	0	3	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	2	0	0	0	2	0	0	1	3	0
21011	Jassa marmorata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21012	Birubius cartoo	4	0	3	1	0	0	0	0	0	0	3	0	0	0	0	3	2	1	2	3	0	1	0	0	3	2	0	6	2	4	3	2	2	1
21013	Brolgus tattersalli	1	0	0	0	1	0	0	2	0	2	0	1	0	0	3	6	2	1	3	3	2	5	5	3	13	8	7	0	0	0	1	0	0	0
21014	Birubius muldarpus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21015	Tipimegus thalerus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
21017	Birubius sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21019	Phoxocephalus burleus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0
21020	Oedicerotidae sp	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21022	Synadexamine runde	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21023	Ampeliscidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21026	Paradexamine dandaloo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
21027	Jassa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21028	Amarylis macrophalamus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21031	Lysianassidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
21036	Amelisca australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	2	1	0
21045	Maera mastersi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21046	Ceradocus rubromaculatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
21047	Protolembos sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9

		9-Cg1.a					11-Ref.a					11-Cg2.a					13-Ref.a					13-Cg2 a					15-Ref.a				15-Cg2.a				
Sp.Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	c	d	e	a	b	c	d	e
21058	Tipimegus thalerus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21059	Ampelisca eurca	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	1	0	0	0	3	1	1	0	2	0	0	0	0	1	0	0	0	0
21065	Paradexamine thadalee	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21066	Tethygeneia sp (MoV 1304)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21073	Eusindae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21074	Tiron sp 1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21081	Byblis mildura	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21084	Aora maculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21088	Photis sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21096	Maera mastersi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21109	Ischyrocerus sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
21110	Cheirophotis sp (cf MoV548)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21111	Aora sp (cf MoV588)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21112	Aoridae sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21113	Booranus sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21114	Booramus weemus	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
21115	Phoxocephalidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21116	Birubius sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21117	Platyischnopidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
21119	Birubius gelarus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
21120	Haustondae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21121	Oedicerlidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21122	Amphipod sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21123	Amphipod sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21124	Phoxocephalidae sp 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21127	Jassa sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0
21130	Liljeborgiidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21131	Amphipod sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21133	Birubius cf pannmunus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22003	Haliophasma cribense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
22005	Natatolana woodjonesi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	0	1	0	0	0	0	0	4	0	0	0
22006	Amakusanthura olearia	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22013	Leptanthura flindersi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
22023	Ispopoda sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22024	Gnathiidea sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22030	Anthuridea sp 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23001	Parasterope sp (MoV 4)	1	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	4	1	0	0	3	12	2	2	2	3
23002	Euphilomedes sp (MoV 18)	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	0	0	0	0	0	0	1	1	9	3	0	5	0
23004	Euphilomedes sp (MoV 1021)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23006	Alternochelata sp (MoV 23)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23011	Cylindrolebendae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23012	Cyprideis sp (MoV 8)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23015	Archasterope sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23018	Ostracoda sp 20	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23019	Archasterope sp (MoV 1019)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24001	cf Apseudes sp 1 (Whiteleggia)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	4	0	0	0	0	3	0	0	0	0	0	0	0	0	0
24002	Kallapseudes sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	1	0	0	0	0	0	0	1	0	0	1	0	0
24004	Leptochelia dubia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
24006	Apseudes sp 1 (Whiteleggia)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	1	0	3	1	0	2	4	1	1	0	0	0	0	0
24008	cf Apseudes sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24010	Leptochelia ignota	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0

		9-Cg1 a					11-Ref.a					11-Cg2.a					13-Ref.a					13-Cg2.a					15-Ref.a				15-Cg2.a				
Sp.Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	c	d	e	a	b	c	d	e
24012	Tanais sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25001	Callianassidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25002	Callianassa limosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
25004	Callianassa arenosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25006	Halicarcinus ovatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
25007	Notomithrax minor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25008	Hexapus granuliferus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25010	Cancer novaehollandiae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25016	Pagurixis handrecki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	1	0	0	0	0	2	1	0	0	0	1	0
25017	Halicarcinus rostratus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
25019	Upogebiidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
25020	Litocheira bispinosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25023	Phlyxia intermedia	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
25024	Decapoda sp 2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25027	Upogebia sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25028	Pinnotheres hickmani	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25029	Hymensomatidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26002	Copepoda sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27001	Dimorphostylis cottoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	3	2	1	1	1
27007	Cyclaspis caprella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27015	Leptocuma sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	1	0	2	0
27016	Cumacea sp 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27018	Cumacea sp.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29001	Caprella sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29005	Nebalia longicornis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
29007	Shrimp sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29008	Leptochela sydniensis	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
31002	Nassarius nigellus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	2	5	8	5	5	8
31004	Macrocolpus roseus	0	0	0	0	0	1	0	0	0	6	0	0	0	0	0	8	0	7	0	9	6	18	9	8	4	16	4	12	5	1	0	3	0	2
31006	Polinices sp 2 (didymus)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31008	Polinices sp 2 (conicus)	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0
31015	Scissurella atkinsoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31020	Rissoellidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31021	Dentimitrella taylorana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31022	Fusinus novaehollandiae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32001	Retusa cf pelyx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33002	Opistobranchia sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33004	Opistobranchia sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33009	Opistobranchia sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
33012	Opistobranchia sp 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34001	Nucula pusilla	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34002	Mysella donaciformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	6	0
34004	Mytilus edulis planulatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34005	Nemocardium thetidis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34009	Theora fragilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34010	Hiatella australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34011	Dosinia cf circinana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
34012	Tellina margantina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34016	Venerupis anomala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34017	Fulvia tenuicostata	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
34021	Notocallista diemenensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		9-Cg1.a					11-Ref.a					11-Cg2.a					13-Ref.a					13-Cg2.a					15-Ref a				15-Cg2.a				
Sp.Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	c	d	e	a	b	c	d	e
34031	Amygdalum beddomei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34032	Bassina disjecta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
34043	Irus carditoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34045	Irus griseus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34050	Bivalve sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37006	Chiton sp 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42003	Patenella regularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42004	Asteroidea sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43001	Amphiura elandiformis	0	0	2	0	0	0	2	1	1	1	1	0	0	2	1	0	0	1	0	0	1	2	2	0	3	2	2	2	3	0	0	0	0	0
43004	Ophuroid sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43005	Ophuroid sp.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43008	Ophiuroid sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
43009	Ophuroid sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44001	Echinocardium cordatum	6	2	2	3	8	0	0	0	0	0	2	0	4	1	2	0	0	0	0	1	1	3	2	0	5	2	2	1	0	18	12	14	9	1
44005	Temnopleurus sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
45004	Holothuroidea sp 4	1	1	5	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45006	Holothuroidea sp 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52001	Anenome sp 1	1	2	2	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
52002	Anenome sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52006	Anenome sp 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61001	Platyhelminthes sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62000	Nemertea un-id	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	2	0	1	0	0	0	0	0	0	3	0	1	1	1	0
63000	Nematoda un-id	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81002	Sipunculan sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81003	Sipunculan sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81004	Sipuncula sp	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91001	Ascidea sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91002	Ascidea sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91003	Ascidea sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94002	Fish sp 2 (weed fish)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94004	Pisces sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96001	Phoronida sp.1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	1	1	0	3	0
96004	Phoronida sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX 1

Appendix 1.2 : Number of individuals recorded from Meads Creek samples.

Species		0-Cg1					0-Ref					0-Cg2					0-St3					0-St4					0-St5				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e
11001	Nephtys australiensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11002	Eunice bassensis	0	0	0	0	0	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11003	Glycera sp 1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
11004	Glycera sp 2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11005	Hesionid sp (MoV 2871)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	2
11007	Hesione sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11010	Neanthes cricognatha	0	0	0	0	1	0	0	0	0	1	1	0	1	1	1	6	3	5	5	11	0	0	0	0	0	1	0	0	0	0
11011	Platynereis dumerilii antipoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11013	Phyllodoce sp (MoV 511)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11015	Lumbrineris sp (MoV 322)	1	0	0	0	0	14	9	4	2	3	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	1	3	0	1
11018	Lumbrinereidae sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11022	Simplisetia amphidonta	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	4	1	0	1	0	0	0	0	0	0	0	0	0	0	1
11023	Sthenelais pettibonae	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11024	Schistomeringos lovei	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11025	Eusyllinae sp (MoV 3096)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0
11026	Epidiopatra sp (MoV 3095)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11027	Harmothoinae sp (MoV 2848)	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
11029	Dorvilleidae sp 2	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11036	Kinbergonuphis sp (MoV 327)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11043	Pilargiidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11056	Syllidae sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11061	Eusyllinae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11065	Eunice sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11073	Pilargidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11074	Lumbrinereidae sp	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11075	Goniadidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11076	Eunicidae sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11077	Polynoidae sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11078	Syllidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13001	Prionospio kulin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
13002	Aricidea sp (MoV 903)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0

Species		0-Cg1					0-Ref					0-Cg2					0-St3					0-St4					0-St5				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e
13003	Aricidea sp (MoV 3092)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13004	Spiophanes kroeyeri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13005	Scalibregma sp (MoV 638)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
13007	Euchone limnicola	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13011	Paraprionospio coora	0	0	0	1	0	0	1	2	0	0	0	0	0	0	0	7	1	5	4	0	0	0	0	0	0	0	5	6	3	1
13016	Diplocirrus sp (MoV 2626)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13018	Aedicira sp	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	7	4
13019	Aedicira sp (MoV 438)	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0
13020	Flabelligeridae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13021	Asychis sp 2 (13079)	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	2	1	2	0	0	0	0	0	0	0	0	0	0
13022	Malacoceros tripartitus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42	0	2	25	0	0	0	0	0	0
13023	Clymenella sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13025	Asychis sp 1 (MoV 907)	3	2	2	2	0	3	6	0	3	8	0	0	0	0	0	5	3	1	2	0	0	0	0	0	0	2	4	8	5	1
13026	Capitella capitata complex	2	3	3	1	14	0	2	1	0	0	1134	1879	753	1342	2289	1336	890	945	2104	1548	0	0	0	19	2	1	0	0	0	0
13027	Mediomastus australiensis	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	11	0	10	10
13029	Paraonides sp (MoV 1358)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
13032	Paraonidae sp (MoV 3093)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
13034	Heteromastus filiformis (MoV 858)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13036	Serpulidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
13040	Phyllamphictels sp (MoV 3094)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1	0	0
13042	Lysilla jennacubinae	0	0	0	0	0	3	0	1	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	6	4
13043	Artacamella dibranchiata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
13045	Eupolymnia koorangia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13047	Pista australis	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	0	0
13049	Aphelochaeta (Tharyx) sp.(MoV 752)	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
13054	Aphelochaeta (Tharyx) sp (MoV 751)	2	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
13055	Chaetozone setosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13058	Prionospio dubia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13059	Leitoscoloplos bifurcatus	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	1	0	3	0	0	0	0	0	0	0	0	0	0	0
13061	Leodamas ohlini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13064	Maldanidae sp 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13065	Terebellides stroemii	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13069	Trichobranchidae sp.1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0
13075	Pectinaria sp.(MoV 636)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
13076	Capitellidae sp 2	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0

Species		0-Cg1					0-Ref					0-Cg2					0-St3					0-St4					0-St5				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e
13090	Isolda pulchella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13118	Polycirrus sp 1 (cf tesselatus)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13120	Pseudopolydora pauchibranchiata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13121	Prionospio wambiri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13149	Ampharetidae sp (MoV 629)+B55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13152	Flabelligeridae sp	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13154	Maldanidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20100	Zoea un-id	1	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	2	0	0	2	3	4	3	1
21001	Lysianassidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21006	Liljeborgia dubia	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21007	Paradexamine dandaloo	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0
21009	Corophium acherusicum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21011	Jassa marmorata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21012	Birubius cartoo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21013	Brolgus tattersalli	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21015	Tipimegus thalerus	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21018	Birubius cartoo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21020	Oedicerotidae sp+B112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0
21023	Ampeliscidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21036	Amelisca australis	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21045	Maera mastersi	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21046	Ceradocus rubromaculatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21047	Protolembos sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21058	Tipimegus thalerus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21059	Ampelisca euroa	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21065	Paradexamine thadalee	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21066	Tethygeneia sp (MoV 1304)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21070	Brolgus tattersalli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21079	Paradexamine spp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21081	Byblis mildura	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21090	Phoxocephalidae spp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21109	Ischyrocerus sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21110	Cheirphotis sp (cf MoV548)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21111	Aora sp (cf MoV588)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21119	Birubius gelarus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		0-Cg1					0-Ref					0-Cg2					0-St3					0-St4					0-St5				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e
21120	Haustoridae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21121	Oedicerotidae sp	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
21125	Eusiridae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21126	Photis sp (cf MoV1300)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21127	Jassa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21128	Corophiid sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21129	Ampelisciphotis sp (MoV547)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21131	Amphipod sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
21133	Birubius cf pannmunus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
22001	Gnathia calamitosa	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22003	Haliophasma cribense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22005	Natatolana woodjonesi	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22006	Amakusanthura oleana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22013	Leptanthura flindersi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
22023	Ispopoda sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	7	1	0	0	0
22029	Isopoda sp 4	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22031	Sphaeromatidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
22032	Sphaeromatidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22033	Sphaeromatidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23001	Parasterope sp.(MoV 4)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
23002	Euphilomedes sp (MoV 18)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0
23004	Euphilomedes sp (MoV 1021)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8	2	7	3
23006	Alternochelata sp (MoV 23)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0
23011	Cylindrolebendae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23013	Cyprodinidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
23015	Archasterope sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
23019	Archasterope sp 1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
24001	cf Apseudes sp.1 (Whiteleggia)	0	0	0	0	0	0	0	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
24002	Kalliapseudes sp 1	0	0	0	0	0	8	7	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
24004	Leptochelia dubia	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24006	Apseudes sp 1 (Whiteleggia)	0	0	0	0	0	1	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24008	cf Apseudes sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25002	Callianassa limosa	0	0	0	0	0	0	1	1	1	0	1	1	0	0	0	1	0	0	0	3	0	0	0	0	0	0	0	0	1	1
25004	Callianassa arenosa	3	0	0	4	0	0	0	0	1	0	0	0	0	0	0	0	3	0	4	1	0	0	0	0	0	0	7	5	3	2
25008	Hexapus granuliferus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		0-Cg1					0-Ref					0-Cg2					0-St3					0-St4					0-St5				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e
25012	Dittosa undecimspinosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25013	Lophopagurus nanus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25016	Pagurixis handrecki	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25020	Litocheira bispinosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
25023	Phlyxia intermedia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25027	Upogebia sp 2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25028	Pinnotheres hickmani	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26001	Copepoda sp.1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
26002	Copepoda sp 2	0	2	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
27001	Dimorphostylis cottoni	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
27003	Tasmanomysis oculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27007	Cyclaspis caprella	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27015	Leptocuma sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27020	Cumacea sp 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29001	Caprella sp 1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0
29005	Nebalia longicornis	0	0	0	0	2	0	0	0	0	0	0	0	0	1	3	7	0	15	0	0	494	0	0	1072	0	0	0	0	1	0
29006	Munida haswelli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29007	Shrimp sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29008	Leptochela sydniensis	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
29015	Caridea sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31001	Zafra atkinsoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31002	Nassarius nigellus	0	0	0	0	1	0	0	0	0	1	5	1	5	8	16	0	0	4	1	1	0	1	0	0	0	21	1	0	8	0
31004	Maoricolpus roseus	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
31008	Polinices sp 2 (conicus)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31021	Dentimitrella taylorana	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31022	Fusinus novaehollandiae	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31024	Sinum zonale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32001	Retusa cf. pelyx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33004	Opistobranchia sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33008	Opistobranchia sp 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
33009	Opistobranchia sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33013	Pleurobranchia maculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34001	Nucula pusilla	1	1	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0
34002	Mysella donaciformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
34004	Mytilus edulis planulatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		0-Cg1					0-Ref					0-Cg2					0-St3					0-St4					0-St5				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e
34005	Nemocardium thetidis	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34006	Thyasira adelaideana	0	0	0	0	0	1	4	1	0	6	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	3	2	0
34008	Corbula gibba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34009	Theora fragilis	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	3	5	1	0	0	0	0	0	1	26	23	57	24
34010	Hiatella australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
34011	Dosinia cf circinaria	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0
34012	Tellina margaritina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
34013	Venericardia bimaculata	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34015	Lasea australis	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34017	Fulvia tenuicostata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34018	Parathyasira resupine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34021	Notocallista diemenensis	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34026	Solamen cf rex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34031	Amygdalum beddomei	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34032	Bassina disjecta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34033	Thracia cf speciosa	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34035	Venerupis sp 2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34043	Irus carditoides	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34045	Irus gnseus	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34046	cf Amygdalum lineum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34047	Myadora brevis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34048	Katelysia scalarina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34049	Solamen recens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37004	Chiton sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37005	Chiton sp 5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38001	Falcidens sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42004	Asteroidea sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43001	Amphiura elandiformis	6	0	2	1	0	1	1	1	2	0	0	0	0	0	0	8	2	0	7	2	0	0	0	0	0	6	4	3	9	4
43009	Ophuroid sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43010	Ophiuroid sp 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44001	Echinocardium cordatum	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44004	Brissus mendionalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
52001	Anenome sp 1	8	0	0	0	0	11	16	2	37	11	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	22	2
52002	Anenome sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52006	Anenome sp 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0

Species		0-Cg1					0-Ref					0-Cg2					0-St3					0-St4					0-St5				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e
61003	Platyhelminthes sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62000	Nemertea un-id	2	0	6	3	0	1	3	3	2	1	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	5	3	3	4
63000	Nematoda un-id	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81001	Sipunculan sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81003	Sipunculan sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91003	Ascidea sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94000	Pisces un-id	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94001	Pseudogobias sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
94003	Fish sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
94004	Pisces sp 4	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
94005	Pisces sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96001	Phoronida sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96004	Phoronida sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX 1

Appendix 1.2 (Cont.) : Number of individuals recorded from Meads Creek samples.

Species		0-St6					0-St7					0-St8					0-St9				0-St10					0-St12					0-St13				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e
11001	Nephtys australiensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
11002	Eunice bassensis	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11003	Glycera sp 1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	2	0	0	3	0
11004	Glycera sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
11005	Hesionid sp (MoV 2871)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1
11007	Hesione sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11010	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	2	0	0	1	0	0	0	0	0	0
11011	Platynereis dumerilii antipoda	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11013	Phyllodoce sp (MoV 511)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
11015	Lumbrinereis sp (MoV 322)	3	0	1	2	0	0	0	0	0	0	3	9	3	3	9	0	3	2	1	0	4	0	0	0	0	0	0	0	0	1	0	1	1	2
11018	Lumbrinereidae sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11022	Simplisetia amphidonta	0	0	0	0	0	0	0	2	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2	0	0	0	0	0
11023	Sthenelais pettibonae	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
11024	Schistomeringos loveni	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11025	Eusyllinae sp (MoV 3096)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
11026	Epidiopatra sp (MoV 3095)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11027	Harmothoinae sp (MoV 2848)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
11029	Dorvilleidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11036	Kinbergonuphis sp (MoV 327)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	2	0	0	0	0	0	0	0	0	0	0
11043	Pilargiidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11056	Syllidae sp.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11061	Eusyllinae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11065	Eunice sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11073	Pilargidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11074	Lumbrinereidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11075	Goniadidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11076	Eunicidae sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11077	Polynoidae sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11078	Syllidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13001	Prionospio kulin	0	0	0	0	0	0	3	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	1	1	0
13002	Aricidea sp (MoV 903)	0	0	0	0	0	0	0	0	0	0	0	2	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		0-St6					0-St7					0-St8					0-St9				0-St10					0-St12					0-St13				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e
13003	Ancidea sp (MoV 3092)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13004	Spiophanes kroeyeri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13005	Scalibregma sp (MoV 638)	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
13007	Euchone limnicola	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13011	Paraprionospio coora	0	1	0	0	0	0	9	1	10	10	2	0	1	0	0	1	0	0	0	0	0	1	0	0	4	14	7	10	0	2	1	3	3	1
13016	Diplocirrus sp (MoV 2626)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13018	Aedicira sp	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
13019	Aedicira sp.(MoV 438)	2	5	0	0	4	0	0	0	1	2	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	2	0	2	0	0	0	0
13020	Flabelligendae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13021	Asychis sp 2 (13079)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
13022	Malacoceros tripartitus	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
13023	Clymenella sp.1	0	0	0	0	0	0	0	0	2	2	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13025	Asychis sp 1 (MoV 907)	1	0	5	0	2	0	1	0	0	1	1	1	0	0	0	0	3	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
13026	Capitella capitata complex	0	0	0	0	2	0	6	0	5	2	0	2	0	3	23	0	0	0	0	0	0	0	2	0	1	1	1	0	0	0	0	0	2	0
13027	Mediomastus australiensis	15	0	1	2	9	0	0	1	0	2	0	6	2	10	6	1	6	7	5	0	4	0	0	0	0	0	0	3	0	6	0	2	2	0
13029	Paraonides sp (MoV 1358)	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
13032	Paraonidae sp (MoV 3093)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13034	Heteromastus filiformis (MoV 858)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13036	Serpulidae sp 1	0	1	1	3	3	0	0	0	0	2	0	0	0	0	0	2	2	0	5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
13040	Phyllamphicteis sp (MoV 3094)	0	8	0	0	0	1	0	0	6	0	0	0	0	2	0	0	0	0	3	2	0	1	0	1	0	2	0	2	3	0	1	1	0	0
13042	Lysilla jennacubinae	5	0	0	3	0	0	0	0	0	0	0	11	0	0	4	0	0	2	0	0	0	0	1	0	2	7	0	2	0	0	0	1	3	0
13043	Artachamella dibranchiata	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13045	Eupolymnia koorangia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
13047	Pista australis	1	0	0	0	0	0	0	0	0	0	10	2	1	10	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13049	Aphelochaeta (Tharyx) sp (MoV 752)	0	2	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	5	0	6	19	0	0	11
13054	Aphelochaeta (Tharyx) sp (MoV 751)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	10	15	0
13055	Chaetozone setosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13058	Prionospio dubia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13059	Leitoscoloplos bifurcatus	0	0	0	0	0	0	0	0	0	0	1	4	0	1	0	0	0	0	0	1	0	0	0	1	0	1	1	1	0	0	1	2	1	2
13061	Leodamas ohlini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7	5	0	0	0	0	0	0	0	0	0	0	0
13064	Maldanidae sp 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13065	Terebellides stroemii	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	0	0	0	8	0	0	0	1	0
13069	Trichobranchidae sp.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
13075	Pectinaria sp (MoV 636)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13076	Capitellidae sp 2	0	14	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		0-St6					0-St7					0-St8					0-St9				0-St10					0-St12					0-St13				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e
13090	Isolda pulchella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13118	Polycirrus sp 1 (cf tesselatus)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13120	Pseudopolydora pauchibranchiata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
13121	Prionospio wambin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13149	Ampharetidae sp (MoV 629)+B55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13152	Flabelligeridae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13154	Maldanidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20100	Zoea un-id	2	0	0	0	1	1	2	0	2	1	0	0	2	1	0	0	0	2	0	0	1	1	1	1	1	2	0	0	0	1	3	2	0	5
21001	Lysianassidae sp 1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21006	Liljeborgia dubia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21007	Paradexamine dandaloo	0	1	0	0	0	0	0	0	0	0	1	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21009	Corophium acherusicum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21011	Jassa marmorata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21012	Birubius cartoo	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	1	0	0	0	0	7	0	3	6	1
21013	Brolgus tattersalli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21015	Tipimegus thalerus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0	0	0	0	0	0	1	0	0	0	1
21018	Birubius cartoo	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21020	Oedicerotidae sp+B112	1	1	0	0	2	0	1	0	0	1	0	0	2	0	0	0	1	2	1	0	0	0	0	1	0	0	0	2	0	2	2	1	0	0
21023	Ampeliscidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21036	Amelisca australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
21045	Maera mastersi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21046	Ceradocus rubromaculatus	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21047	Protolembos sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21058	Tipimegus thalerus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21059	Ampelisca euroa	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
21065	Paradexamine thadalee	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21066	Tethygenera sp (MoV 1304)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21070	Brolgus tattersalli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21079	Paradexamine spp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21081	Byblis mildura	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
21090	Phoxocephalidae spp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21109	Ischyrocerus sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21110	Cheirophotis sp (cf MoV548)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21111	Aora sp (cf MoV588)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21119	Birubius gelarus	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		0-St6					0-St7					0-St8					0-St9					0-St10					0-St12					0-St13				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e
21120	Haustoriidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
21121	Oedicerotidae sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21125	Eusiridae sp	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21126	Photis sp (cf MoV1300)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21127	Jassa sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21128	Corophiid sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21129	Ampelisciphotis sp (MoV547)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21131	Amphipod sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21133	Birubius cf pannmunus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22001	Gnathia calamitosa	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22003	Haliophasma cribense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22005	Natatolana woodjonesi	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
22006	Amakusanthura oleana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22013	Leptanthura flindersi	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22023	Ispopoda sp 2	3	2	0	0	4	0	0	0	0	0	0	0	0	0	0	2	2	0	3	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
22029	Isopoda sp 4	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22031	Sphaeromatidae sp	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22032	Sphaeromatidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22033	Sphaeromatidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23001	Parasterope sp (MoV 4)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
23002	Euphilomedes sp (MoV 18)	2	8	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3	1	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
23004	Euphilomedes sp (MoV 1021)	4	6	1	2	9	0	0	0	0	0	0	0	0	0	0	2	1	2	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
23006	Alternochelata sp.(MoV 23)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23011	Cylindroleberidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
23013	Cyprididae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23015	Archasterope sp.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
23019	Archasterope sp 1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24001	cf Apseudes sp 1 (Whiteleggia)	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24002	Kalliapseudes sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24004	Leptochelia dubia	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24006	Apseudes sp 1 (Whiteleggia)	0	0	0	0	0	0	0	0	0	0	3	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24008	cf Apseudes sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25002	Callianassa limosa	0	0	0	0	0	0	3	1	0	0	1	0	0	3	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
25004	Callianassa arenosa	0	0	0	1	2	3	0	2	7	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	1	0	2
25008	Hexapus granuliferus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		0-St6					0-St7					0-St8					0-St9				0-St10					0-St12					0-St13				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e
25012	Dittosa undecimspinosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25013	Lophopagurus nanus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25016	Pagurixis handrecki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25020	Litocheira bispinosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25023	Phlyxia intermedia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
25027	Upogebia sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25028	Pinnotheres hickmani	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26001	Copepoda sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	2	0	0
26002	Copepoda sp 2	1	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
27001	Dimorphostylis cottoni	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
27003	Tasmanomysis oculata	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
27007	Cyclaspis caprella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
27015	Leptocuma sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0
27020	Cumacea sp 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29001	Caprella sp.1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29005	Nebalia longicornis	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29006	Munida haswelli	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29007	Shrimp sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29008	Leptochela sydniensis	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
29015	Candea sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31001	Zafra atkinsoni	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31002	Nassarius nigellus	1	9	0	0	5	0	6	2	4	0	0	0	1	0	0	1	3	2	2	0	2	0	2	1	0	1	4	0	6	2	1	2	1	6
31004	Maoricolpus roseus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
31008	Polinices sp 2 (conicus)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31021	Dentimitrella taylorana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31022	Fusinus novaehollandiae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31024	Sinum zonale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32001	Retusa cf pelyx	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33004	Opistobranchia sp 4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
33008	Opistobranchia sp 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33009	Opistobranchia sp.9	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33013	Pleurobranchia maculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34001	Nucula pusilla	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0
34002	Mysella donaciformis	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
34004	Mytilus edulis planulatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		0-St6					0-St7					0-St8					0-St9				0-St10					0-St12					0-St13				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e
34005	Nemocardium thetidis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
34006	Thyasira adelaideana	8	3	7	0	7	0	0	1	0	0	0	0	0	0	1	7	11	8	7	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
34008	Corbula gibba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34009	Theora fragilis	7	18	8	4	11	16	17	16	38	9	0	1	3	1	0	3	2	11	3	0	1	5	2	4	37	33	29	16	68	4	5	9	0	4
34010	Hiatella australis	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34011	Dosinia cf circinaria	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34012	Tellina margaritina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
34013	Venericardia bimaculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34015	Lasea australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34017	Fulvia tenuicostata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34018	Parathyasira resupine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34021	Notocallista diemenensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34026	Solamen cf rex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34031	Amygdalum beddomei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34032	Bassina disjecta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34033	Thracia cf speciosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34035	Venerupis sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34043	Irus carditoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34045	Irus griseus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34046	cf Amygdalum lineum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34047	Myadora brevis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
34048	Katelysia scalarina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
34049	Solamen recens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37004	Chiton sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37005	Chiton sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38001	Falcidens sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42004	Asteroidea sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43001	Amphiura elandiformis	3	0	3	4	8	2	1	5	7	1	0	0	1	0	0	5	8	6	5	0	0	0	1	0	0	0	0	3	0	0	0	1	0	1
43009	Ophuroid sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
43010	Ophiuroid sp 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44001	Echinocardium cordatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	2	0	1	1	0	0	0	0	0	1	1	1	3	1
44004	Brissus mendionalis	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52001	Anenome sp 1	6	0	4	0	17	0	0	0	0	0	3	6	2	1	1	5	5	5	6	2	0	1	1	1	0	0	0	0	0	0	2	0	0	0
52002	Anenome sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52006	Anenome sp 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		0-St6					0-St7					0-St8					0-St9				0-St10					0-St12					0-St13				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e
61003	Platyhelminthes sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62000	Nemertea un-id	2	0	1	2	17	1	0	2	2	7	1	2	0	1	1	1	2	5	0	1	0	0	1	0	3	0	1	4	4	0	2	0	1	0
63000	Nematoda un-id	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81001	Sipunculan sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81003	Sipunculan sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91003	Ascidea sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
94000	Pisces un-id	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94001	Pseudogobias sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94003	Fish sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94004	Pisces sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
94005	Pisces sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96001	Phoronida sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
96004	Phoronida sp.4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX 1

Appendix 1.2 (Cont.) : Number of individuals recorded from Meads Creek samples.

Species		2-Ref					2-Cg2					2-Cg1					4-Ref					4-Cg2				4-Cg1					6-Ref				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	e	a	b	c	d	e	a	b	c	d	e
11001	Nephtys australiensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11002	Eunice bassensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11003	Glycera sp 1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
11004	Glycera sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11005	Hesionid sp (MoV 2871)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11007	Hesione sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11010	Neanthes cricognatha	0	0	0	0	0	3	1	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0
11011	Platynereis dumerilii antipoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11013	Phyllodoce sp (MoV 511)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11015	Lumbrinereis sp (MoV 322)	0	0	1	1	5	6	5	0	2	2	0	0	0	0	0	0	0	0	4	2	0	0	0	2	0	0	0	0	0	1	2	1	0	0
11018	Lumbrinereidae sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11022	Simplisetia amphidonta	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
11023	Sthenelais pettibonae	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0
11024	Schistomeringos loveni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11025	Eusyllinae sp (MoV 3096)	0	1	1	0	0	8	7	4	3	4	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
11026	Epidiopatra sp (MoV 3095)	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11027	Harmothoinae sp (MoV 2848)	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11029	Dorvilleidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11036	Kinbergonuphis sp (MoV 327)	0	0	0	0	0	0	0	1	0	3	0	0	0	0	0	0	0	0	0	0	1	10	8	6	0	0	0	0	0	0	0	0	0	0
11043	Pilargiidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11056	Syllidae sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11061	Eusyllinae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11065	Eunice sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11073	Pilargidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11074	Lumbrinereidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
11075	Goniadidae sp.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
11076	Eunicidae sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11077	Polynoidae sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
11078	Syllidae sp	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13001	Prionospio kulin	0	0	0	0	0	0	3	0	6	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13002	Aricidea sp (MoV 903)	0	1	0	0	0	0	1	0	3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		2-Ref					2-Cg2					2-Cg1					4-Ref					4-Cg2				4-Cg1					6-Ref				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	e	a	b	c	d	e	a	b	c	d	e
13003	Ancidea sp (MoV 3092)	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
13004	Spiophanes kroeyeri	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
13005	Scalibregma sp (MoV 638)	0	0	0	0	2	2	0	1	0	0	0	0	0	0	0	0	0	2	5	2	1	1	3	1	0	0	0	0	0	0	0	0	0	0
13007	Euchone limnicola	0	1	0	2	0	1	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
13011	Paraprionospio coora	0	0	0	2	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	4	3	0	0	0	0	0	0	0	0	0	0
13016	Diplocirrus sp (MoV 2626)	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13018	Aedicira sp	5	2	5	4	11	0	12	12	13	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0	0
13019	Aedicira sp (MoV 438)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13020	Flabelligendae sp 1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13021	Asychis sp 2 (13079)	0	0	1	0	0	2	0	1	4	0	0	0	0	0	0	0	0	0	3	0	0	0	4	0	0	0	0	0	0	0	0	1	1	0
13022	Malacoceros tripartitus	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13023	Clymenella sp 1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
13025	Asychis sp 1 (MoV 907)	0	0	1	2	6	0	0	0	0	0	0	0	0	0	0	0	1	2	2	1	1	5	1	1	0	0	0	0	0	0	0	1	0	1
13026	Capitella capitata complex	0	0	0	0	1	17	46	33	31	0	134	1	0	0	0	0	0	0	0	0	0	4	0	2	133	0	107	31	6	0	0	0	0	0
13027	Mediomastus australiensis	6	2	6	5	37	32	7	0	17	5	0	0	0	0	0	0	0	0	1	0	1	2	1	0	0	0	0	0	0	1	2	4	0	0
13029	Paraonides sp (MoV 1358)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13032	Paraonidae sp.(MoV 3093)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13034	Heteromastus filiformis (MoV 858)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
13036	Serpulidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	3	0	0	0	0	0	0	0	0	5	0	0
13040	Phyllamphicteis sp. (MoV 3094)	0	0	0	0	0	0	2	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13042	Lysilla jennacubinae	0	2	0	3	0	3	4	3	0	0	0	0	0	0	0	3	3	5	4	0	0	0	3	0	0	0	0	0	0	1	2	2	1	4
13043	Artacamella dibranchiata	0	0	1	1	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
13045	Eupolymnia koorangia	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13047	Pista australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13049	Aphelochaeta (Tharyx) sp (MoV 752)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
13054	Aphelochaeta (Tharyx) sp (MoV 751)	0	1	1	0	2	1	4	1	5	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
13055	Chaetozone setosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13058	Prionospio dubia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13059	Leitoscoloplos bifurcatus	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13061	Leodamas ohlini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13064	Maldanidae sp 8	0	0	0	0	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13065	Terebellides stroemii	2	0	0	0	1	0	0	0	0	1	0	0	0	0	0	4	1	0	0	7	1	4	5	2	0	0	0	0	0	1	0	0	0	0
13069	Trichobranchidae sp 1	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13075	Pectinaria sp.(MoV 636)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13076	Capitellidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		2-Ref					2-Cg2					2-Cg1					4-Ref					4-Cg2					4-Cg1					6-Ref				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	e	a	b	c	d	e	a	b	c	d	e
13090	Isolda pulchella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13118	Polycirrus sp 1 (cf tesselatus)	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13120	Pseudopolydora pauchibranchiata	0	0	0	0	0	6	8	1	13	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13121	Pnonospio wambin	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13149	Ampharetidae sp (MoV 629)+B55	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	0	0	0	0	0	0	0	0	0	0
13152	Flabelligeridae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13154	Maldanidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	4	3	5	26	3	8	0	0	0	0	0	0	0	0	0	0
20100	Zoea un-id	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21001	Lysianassidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21006	Liljeborgia dubia	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21007	Paradexamine dandaloo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21009	Corophium acherusicum	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21011	Jassa marmorata	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21012	Birubius cartoo	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21013	Brolgus tattersalli	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21015	Tipimegus thalerus	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21018	Birubius cartoo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21020	Oedicerotidae sp+B112	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
21023	Ampeliscidae sp 1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21036	Amelisca australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0
21045	Maera mastersi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21046	Ceradocus rubromaculatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21047	Protolembos sp 1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21058	Tipimegus thalerus	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21059	Ampelisca euroa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21065	Paradexamine thadalee	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21066	Tethygeneia sp (MoV 1304)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21070	Brolgus tattersalli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21079	Paradexamine spp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21081	Byblis mildura	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21090	Phoxocephalidae spp	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21109	Ischyrocerus sp	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21110	Cheirophotis sp (cf MoV548)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21111	Aora sp (cf MoV588)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21119	Birubius gelarus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		2-Ref					2-Cg2					2-Cg1					4-Ref					4-Cg2					4-Cg1					6-Ref				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	e	a	b	c	d	e	a	b	c	d	e
21120	Haustoriidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21121	Oedicerotidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21125	Eusiridae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
21126	Photis sp (cf MoV1300)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
21127	Jassa sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21128	Corophiid sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21129	Ampelisciphotis sp (MoV547)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
21131	Amphipod sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21133	Birubius cf pannmunus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22001	Gnathia calamitosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22003	Haliophasma cribense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22005	Natatolana woodjonesi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
22006	Amakusanthura oleana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22013	Leptanthura flindersi	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22023	Ispopoda sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22029	Isopoda sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22031	Sphaeromatidae sp	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22032	Sphaeromatidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22033	Sphaeromatidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23001	Parasterope sp (MoV 4)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23002	Euphilomedes sp (MoV 18)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23004	Euphilomedes sp (MoV 1021)	0	0	3	1	2	0	0	0	0	0	0	0	0	0	0	0	1	2	3	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0
23006	Alternochelata sp (MoV 23)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23011	Cylindrolebendae sp.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23013	Cyprididae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23015	Archasterope sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23019	Archasterope sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24001	cf Apseudes sp 1 (Whiteleggia)	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24002	Kalliapseudes sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24004	Leptochelia dubia	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24006	Apseudes sp.1 (Whiteleggia)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24008	cf Apseudes sp 2	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
25002	Callianassa limosa	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	1	0	0	3	2	0	0	0	0	0	0	0	0	2	1	0
25004	Callianassa arenosa	0	0	0	0	0	2	2	3	0	0	0	0	0	0	0	3	0	2	0	2	2	0	0	0	0	1	0	0	0	1	4	0	0	0
25008	Hexapus granuliferus	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		2-Ref					2-Cg2					2-Cg1					4-Ref					4-Cg2				4-Cg1					6-Ref				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	e	a	b	c	d	e	a	b	c	d	e
25012	Dittosa undecimspinosa	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
25013	Lophopagurus nanus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25016	Paguristes handrecki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25020	Litocheira bispinosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25023	Phlyxia intermedia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25027	Upogebia sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25028	Pinnotheres hickmani	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
26001	Copepoda sp.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26002	Copepoda sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27001	Dimorphostylis cottoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27003	Tasmanomysis oculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27007	Cyclaspis caprella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27015	Leptocuma sp 1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27020	Cumacea sp 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29001	Caprella sp 1	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29005	Nebalia longicornis	0	0	0	0	0	0	0	0	0	0	15	0	0	0	13	0	0	0	0	0	0	0	0	0	1	0	151	0	0	0	0	0	0	0
29006	Munida haswelli	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
29007	Shrimp sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
29008	Leptochela sydniensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0
29015	Candea sp 5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31001	Zafra atkinsoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31002	Nassarius nigellus	0	0	0	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31004	Maoricolpus roseus	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31008	Polinices sp 2 (conicus)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31021	Dentimitrella taylorana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31022	Fusinus novaehollandiae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31024	Sinum zonale	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32001	Retusa cf. pelyx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33004	Opistobranchia sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
33008	Opistobranchia sp 8	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33009	Opistobranchia sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33013	Pleurobranchia maculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
34001	Nucula pusilla	1	1	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
34002	Mysella donaciformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34004	Mytilus edulis planulatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		2-Ref					2-Cg2					2-Cg1					4-Ref					4-Cg2				4-Cg1					6-Ref				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	e	a	b	c	d	e	a	b	c	d	e
34005	Nemocardium thetidis	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
34006	Thyasira adelaideana	1	2	4	1	6	1	1	1	0	0	0	0	0	0	0	4	0	0	4	1	0	6	2	1	0	0	0	0	0	0	0	0	1	0
34008	Corbula gibba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34009	Theora fragilis	0	0	0	3	4	3	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
34010	Hiatella australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34011	Dosinia cf. circinana	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34012	Tellina margaritina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34013	Venericardia bimaculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34015	Lasea australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34017	Fulvia tenuicostata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34018	Parathyasira resupine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
34021	Notocallista diemenensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34026	Solamen cf rex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34031	Amygdalum beddomei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
34032	Bassina disjecta	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34033	Thracia cf speciosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34035	Venerupis sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34043	Irus carditoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34045	Irus gnseus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34046	cf Amygdalum lineum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
34047	Myadora brevis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34048	Katelysia scalarina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34049	Solamen recens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37004	Chiton sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37005	Chiton sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38001	Falcidens sp 1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
42004	Asteroidea sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43001	Amphiura elandiformis	2	4	4	5	5	0	1	1	0	0	0	0	0	0	0	6	3	3	3	7	5	2	3	1	0	0	0	0	0	1	4	5	5	2
43009	Ophuroid sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43010	Ophiuroid sp 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44001	Echinocardium cordatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44004	Brissus mendionalis	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
52001	Anenome sp 1	0	0	0	2	1	1	2	0	0	1	0	0	0	0	0	0	0	3	0	7	1	3	0	0	0	0	0	0	0	1	1	0	1	0
52002	Anenome sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52006	Anenome sp 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		2-Ref					2-Cg2					2-Cg1					4-Ref					4-Cg2					4-Cg1					6-Ref				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	e	a	b	c	d	e	a	b	c	d	e
61003	Platyhelminthes sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
62000	Nemertea un-id	2	0	1	0	3	7	4	3	3	3	0	0	1	0	0	0	1	0	1	0	1	1	0	2	3	6	0	2	3	1	0	1	1	0
63000	Nematoda un-id	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
81001	Sipunculan sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
81003	Sipunculan sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
91003	Ascidea sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94000	Pisces un-id	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94001	Pseudogobias sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94003	Fish sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94004	Pisces sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94005	Pisces sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96001	Phoronida sp 1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96004	Phoronida sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX 1

Appendix 1.2 (Cont.) : Number of individuals recorded from Meads Creek samples.

Species		6-Cg2					6-Cg1					9-Ref					9-Cg2					9-Cg1				11-Ref					11-Cg2				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	c	d	e	a	b	c	d	e	a	b	c	d	e
11001	Nephtys australiensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11002	Eunice bassensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	4	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
11003	Glycera sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11004	Glycera sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11005	Hesionid sp (MoV 2871)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
11007	Hesione sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11010	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11011	Platynereis dumerilii antipoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11013	Phyllodoce sp (MoV 511)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11015	Lumbrinereis sp (MoV 322)	0	0	0	1	2	0	0	0	0	0	1	1	1	2	1	0	2	0	1	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0
11018	Lumbrinereidae sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11022	Simplisetia amphidonta	0	0	0	0	0	2	1	3	4	1	0	0	0	0	0	0	0	0	0	0	1	1	2	1	0	0	0	0	0	0	0	2	0	0
11023	Sthenelais pettibonae	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0
11024	Schistomeringos loveni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
11025	Eusyllinae sp (MoV 3096)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
11026	Epidiopatra sp (MoV 3095)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11027	Harmothoinae sp (MoV 2848)	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
11029	Dorvilleidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11036	Kinbergonuphis sp (MoV 327)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11043	Pilargidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11056	Syllidae sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11061	Eusyllinae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11065	Eunice sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11073	Pilargidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11074	Lumbrinereidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
11075	Goniadidae sp 1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11076	Eunicidae sp 4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11077	Polynoidae sp.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11078	Syllidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13001	Prionospio kulin	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
13002	Aricidea sp (MoV 903)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		6-Cg2					6-Cg1					9-Ref					9-Cg2					9-Cg1				11-Ref					11-Cg2				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	c	d	e	a	b	c	d	e	a	b	c	d	e
13003	Aricidea sp (MoV 3092)	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
13004	Spiophanes kroeyeri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13005	Scalibregma sp (MoV 638)	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13007	Euchone limnicola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13011	Paraprionospio coora	0	0	0	3	0	3	4	7	10	2	18	1	2	1	0	3	1	1	0	0	8	10	8	10	0	0	1	0	0	0	0	0	0	0
13016	Diplocirrus sp (MoV 2626)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13018	Aedicira sp	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13019	Aedicira sp (MoV 438)	0	0	0	0	0	0	0	0	0	0	0	0	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13020	Flabelligendae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13021	Asychis sp 2 (13079)	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13022	Malacoceros tripartitus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13023	Clymenella sp 1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13025	Asychis sp 1 (MoV 907)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	1	1	3	1	1	0	0	1	0
13026	Capitella capitata complex	0	0	0	0	0	0	1	0	0	0	79	0	0	1	0	0	1	0	0	0	132	80	14	52	0	0	0	0	0	13	7	15	76	33
13027	Mediomastus australiensis	0	0	0	0	1	0	0	0	0	0	1	3	4	0	1	0	1	0	3	4	0	0	0	0	0	0	0	0	1	0	0	0	0	0
13029	Paraonides sp (MoV 1358)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13032	Paraonidae sp (MoV 3093)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13034	Heteromastus filiformis (MoV 858)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13036	Serpulidae sp 1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
13040	Phyllamphictels sp. (MoV 3094)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13042	Lysilla jennacubinae	0	0	0	0	0	0	0	0	0	0	2	2	1	3	4	0	4	0	0	2	0	0	0	0	0	1	1	3	4	0	0	0	0	0
13043	Artachamella dibranchiata	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
13045	Eupolymnia koorangia	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13047	Pista australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13049	Aphelochaeta (Tharyx) sp (MoV 752)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13054	Aphelochaeta (Tharyx) sp (MoV 751)	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13055	Chaetozone setosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13058	Prionospio dubia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13059	Leitoscoloplos bifurcatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13061	Leodamas ohlini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13064	Maldanidae sp 8	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
13065	Terebellides stroemii	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
13069	Trichobranchidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13075	Pectinaria sp.(MoV 636)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13076	Capitellidae sp.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		6-Cg2					6-Cg1					9-Ref					9-Cg2					9-Cg1				11-Ref					11-Cg2				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	c	d	e	a	b	c	d	e	a	b	c	d	e
13090	Isolda pulchella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13118	Polycirrus sp 1 (cf tesselatus)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13120	Pseudopolydora pauchibranchiata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
13121	Prionospio wambin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13149	Ampharetidae sp (MoV 629)+B55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13152	Flabelligeridae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13154	Maldanidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	2	3	0	0	0	0	0	0
20100	Zoea un-id	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
21001	Lysianassidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21006	Liljeborgia dubia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21007	Paradexamine dandaloo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21009	Corophium acherusicum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21011	Jassa marmorata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21012	Birubius cartoo	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21013	Brolgus tattersalli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0	0	0
21015	Tipimegus thalerus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21018	Birubius cartoo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21020	Oedicerotidae sp+B112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21023	Ampeliscidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21036	Amelisca australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21045	Maera mastersi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21046	Ceradocus rubromaculatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21047	Protolembos sp 1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21058	Tipimegus thalerus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21059	Ampelisca euroa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21065	Paradexamine thadalee	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21066	Tethygeneia sp (MoV 1304)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21070	Brolgus tattersalli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21079	Paradexamine spp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21081	Byblis mildura	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21090	Phoxocephalidae spp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21109	Ischyrocerus sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21110	Cheirophotis sp (cf MoV548)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21111	Aora sp (cf MoV588)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21119	Birubius gelarus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		6-Cg2					6-Cg1					9-Ref					9-Cg2					9-Cg1				11-Ref					11-Cg2				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	c	d	e	a	b	c	d	e	a	b	c	d	e
21120	Haustondae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21121	Oedicertidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21125	Eusindae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21126	Photis sp (cf MoV1300)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21127	Jassa sp	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21128	Corophiid sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21129	Ampeliscphotis sp (MoV547)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21131	Amphipod sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21133	Birubius cf pannmunus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22001	Gnathia calamitosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
22003	Haliophasma cribense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22005	Natatolana woodjonesi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22006	Amakusanthura oleana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22013	Leptanthura flindersi	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
22023	Ispopoda sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22029	Isopoda sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22031	Sphaeromatidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22032	Sphaeromatidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22033	Sphaeromatidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23001	Parasterope sp (MoV 4)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23002	Euphilomedes sp.(MoV 18)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23004	Euphilomedes sp (MoV 1021)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
23006	Alternochelata sp (MoV 23)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23011	Cylindrolebendae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
23013	Cyprdinidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23015	Archasterope sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23019	Archasterope sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24001	cf Apseudes sp 1 (Whiteleggia)	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	24	2	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24002	Kalliapseudes sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24004	Leptochelia dubia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24006	Apseudes sp 1 (Whiteleggia)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24008	cf Apseudes sp 2	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25002	Callianassa limosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25004	Callianassa arenosa	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
25008	Hexapus granuliferus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		6-Cg2					6-Cg1					9-Ref					9-Cg2					9-Cg1				11-Ref					11-Cg2				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	c	d	e	a	b	c	d	e	a	b	c	d	e
25012	Dittosa undecimspinosa	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25013	Lophopagurus nanus	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25016	Paguristes handrecki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25020	Litocheira bispinosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25023	Phlyxia intermedia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25027	Upogebia sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25028	Pinnotheres hickmani	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26001	Copepoda sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
26002	Copepoda sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27001	Dimorphostylis cottoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27003	Tasmanomysis oculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27007	Cyclaspis caprella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27015	Leptocuma sp.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27020	Cumacea sp 12	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29001	Caprella sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29005	Nebalia longicornis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29006	Munida haswelli	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
29007	Shrimp sp.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29008	Leptochela sydniensis	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29015	Candea sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31001	Zafra atkinsoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31002	Nassarius nigellus	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0
31004	Maoricolpus roseus	0	0	0	0	0	0	0	0	0	0	20	30	6	16	9	15	13	15	6	3	8	4	6	9	8	0	0	3	9	0	0	16	0	0
31008	Polinices sp 2 (conicus)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31021	Dentimitrella taylorana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31022	Fusinus novaehollandiae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31024	Sinum zonale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32001	Retusa cf pelyx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33004	Opistobranchia sp.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33008	Opistobranchia sp 8	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33009	Opistobranchia sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33013	Pleurobranchia maculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34001	Nucula pusilla	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
34002	Mysella donaciformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34004	Mytilus edulis planulatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		6-Cg2					6-Cg1					9-Ref					9-Cg2					9-Cg1				11-Ref					11-Cg2				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	c	d	e	a	b	c	d	e	a	b	c	d	e
34005	Nemocardium thetidis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34006	Thyasira adelaideana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
34008	Corbula gibba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34009	Theora fragilis	0	0	0	0	0	9	3	3	0	3	23	0	0	0	0	0	0	0	0	0	20	4	4	4	0	0	0	0	0	0	0	0	0	0
34010	Hiatella australis	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34011	Dosinia cf circinana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34012	Tellina margantina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34013	Venericardia bimaculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34015	Lasea australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34017	Fulvia tenuicostata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34018	Parathyasira resupine	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34021	Notocallista diemenensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34026	Solamen cf rex	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34031	Amygdalum beddomei	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34032	Bassina disjecta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34033	Thracia cf speciosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34035	Venerupis sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34043	Irus carditoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34045	Irus gnseus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34046	cf Amygdalum lineum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
34047	Myadora brevis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34048	Katelysia scalarina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34049	Solamen recens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37004	Chiton sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37005	Chiton sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38001	Falcidens sp.1	0	0	1	0	1	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42004	Asteroidea sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43001	Amphiura elandiformis	1	0	0	3	2	0	0	0	0	0	27	3	11	3	5	1	0	0	0	0	0	0	0	0	3	4	4	2	5	0	0	0	0	0
43009	Ophuroid sp 9	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43010	Ophiuroid sp 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44001	Echinocardium cordatum	0	0	0	0	0	5	13	6	0	6	0	0	0	0	0	0	0	0	0	0	22	23	38	22	0	0	0	0	0	0	0	0	0	0
44004	Brissus mendionalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52001	Anenome sp 1	2	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52002	Anenome sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52006	Anenome sp.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		6-Cg2					6-Cg1					9-Ref					9-Cg2					9-Cg1				11-Ref					11-Cg2				
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	c	d	e	a	b	c	d	e	a	b	c	d	e
61003	Platyhelminthes sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62000	Nemertea un-id	1	0	1	2	2	0	1	0	0	0	2	3	3	2	1	0	2	0	0	0	1	1	0	0	1	0	0	1	2	0	0	0	0	0
63000	Nematoda un-id	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81001	Sipuncular sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81003	Sipuncular sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91003	Ascidea sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94000	Pisces un-id	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94001	Pseudogobias sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94003	Fish sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94004	Pisces sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94005	Pisces sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
96001	Phoronida sp 1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96004	Phoronida sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX 1

Appendix 1.2 (Cont.) : Number of individuals recorded from Meads Creek samples.

Species		11-Cg1					13-Ref					13-Cg2					13-Cg1					15-Ref					15-Cg2			15-Cg1			
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	d	e	a	c	d	e
11001	Nephtys australiensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11002	Eunice bassensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
11003	Glycera sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11004	Glycera sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11005	Hesionid sp (MoV 2871)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11007	Hesione sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11010	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0	7	0	6	5	4	1	1	0	0	0	0	0	0	0	0	0	1	0	1	3	0	1
11011	Platynereis dumerilii antipoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11013	Phyllodoce sp (MoV 511)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11015	Lumbrinereis sp (MoV 322)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11018	Lumbrinereidae sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11022	Simplisetia amphidonta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	1	1	2
11023	Sthenelais pettibonae	0	0	0	0	0	2	0	1	2	1	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0
11024	Schistomeringos loveni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11025	Eusyllinae sp (MoV 3096)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11026	Epidiopatra sp (MoV 3095)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11027	Harmothoinae sp (MoV 2848)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11029	Dorvilleidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11036	Kinbergonuphis sp (MoV 327)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11043	Pilargidae sp.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
11056	Syllidae sp.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11061	Eusyllinae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11065	Eunice sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11073	Pilargidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11074	Lumbrinereidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11075	Goniadidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11076	Eunicidae sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11077	Polynoidae sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11078	Syllidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13001	Prionospio kulin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0
13002	Ancidea sp (MoV 903)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		11-Cg1					13-Ref					13-Cg2					13-Cg1					15-Ref					15-Cg2			15-Cg1			
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	d	e	a	c	d	e
13003	Aricidea sp (MoV 3092)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13004	Spiophanes kroeyeri	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13005	Scalibregma sp (MoV 638)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4	0	0	0	0	0	0	0	0
13007	Euchone limnicola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
13011	Paraprionospio coora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
13016	Diplocirrus sp (MoV 2626)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13018	Aedicira sp	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0
13019	Aedicira sp (MoV 438)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13020	Flabelligeridae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13021	Asychis sp 2 (13079)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	4	5	3	0	0	0	0	0	0	0
13022	Malacoceros tripartitus	2	1	3	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	5	2	1	4
13023	Clymenella sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13025	Asychis sp 1 (MoV 907)	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	1	0	1	2	2	1	0	0	0	0	0	0	0	0
13026	Capitella capitata complex	14	144	2	161	2	0	0	0	0	0	125	37	92	82	50	1	0	0	0	1	0	0	0	0	0	582	196	195	92	15	15	27
13027	Mediomastus australiensis	0	0	0	0	0	0	4	1	2	0	0	0	0	0	0	0	0	0	0	0	8	6	6	2	4	0	0	0	0	0	0	0
13029	Paraonides sp (MoV 1358)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
13032	Paraonidae sp (MoV 3093)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13034	Heteromastus filiformis (MoV 858)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13036	Serpulidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
13040	Phyllamphicteis sp (MoV 3094)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13042	Lysilla jennacubinae	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	3	4	2	0	0	0	0	0	0	0
13043	Artachamella dibranchiata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13045	Eupolymnia koorangia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
13047	Pista australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13049	Aphelochaeta (Tharyx) sp (MoV 752)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13054	Aphelochaeta (Tharyx) sp (MoV 751)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
13055	Chaetozone setosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
13058	Prionospio dubia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13059	Leitoscoloplos bifurcatus	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13061	Leodamas ohlini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13064	Maldanidae sp 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13065	Terebellides stroemii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0	1	0	0	0	0	0	0	0	0
13069	Trichobranchidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13075	Pectinaria sp (MoV 636)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13076	Capitellidae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		11-Cg1					13-Ref					13-Cg2					13-Cg1					15-Ref					15-Cg2			15-Cg1			
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	d	e	a	c	d	e
13090	Isolda pulchella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13118	Polycirrus sp 1 (cf tesselatus)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13120	Pseudopolydora pauchibranchiata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13121	Prionospio wambiri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13149	Ampharetidae sp (MoV 629)+B55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13152	Flabelligendae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13154	Maldanidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20100	Zoea un-id	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
21001	Lysianassidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21006	Liljeborgia dubia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21007	Paradexamine dandaloo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21009	Corophium acherusicum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21011	Jassa marmorata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21012	Birubius cartoo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21013	Brolgus tattersalli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21015	Tipimegus thalerus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21018	Birubius cartoo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21020	Oedicerotidae sp+B112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
21023	Ampeliscidae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21036	Amelisca australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21045	Maera mastersi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21046	Ceradocus rubromaculatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21047	Protolembos sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21058	Tipimegus thalerus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21059	Ampelisca euroa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21065	Paradexamine thadalee	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21066	Tethygeneia sp (MoV 1304)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21070	Brolgus tattersalli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21079	Paradexamine spp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21081	Byblis mildura	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21090	Phoxocephalidae spp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21109	Ischyrocerus sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21110	Cheirnphotis sp (cf MoV548)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21111	Aora sp (cf MoV588)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21119	Birubius gelarus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species		11-Cg1					13-Ref					13-Cg2					13-Cg1					15-Ref					15-Cg2			15-Cg1			
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	d	e	a	c	d	e
21120	Haustoridae sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21121	Oedicertidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21125	Eusiridae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21126	Photis sp (cf MoV1300)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21127	Jassa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21128	Corophiid sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21129	Ampelisciphotis sp. (MoV547)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
21131	Amphipod sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21133	Birubius cf pannmunus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22001	Gnathia calamitosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22003	Haliophasma cribense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22005	Natatolana woodjonesi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22006	Amakusanthura oleana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22013	Leptanthura flindersi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
22023	Ispopoda sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22029	Isopoda sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22031	Sphaeromatidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22032	Sphaeromatidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
22033	Sphaeromatidae sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
23001	Parasterope sp (MoV 4)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23002	Euphilomedes sp (MoV 18)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
23004	Euphilomedes sp (MoV 1021)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	6	3	2	0	2	0	0	0	0	0	0	0
23006	Alternochelata sp (MoV 23)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23011	Cylindrolebendae sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23013	Cyprididae sp.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23015	Archasterope sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23019	Archasterope sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24001	cf Apseudes sp 1 (Whiteleggia)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
24002	Kalliapseudes sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
24004	Leptochelia dubia	0	0	0	1	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
24006	Apseudes sp 1 (Whiteleggia)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24008	cf Apseudes sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25002	Callianassa limosa	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
25004	Callianassa arenosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
25008	Hexapus granuliferus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

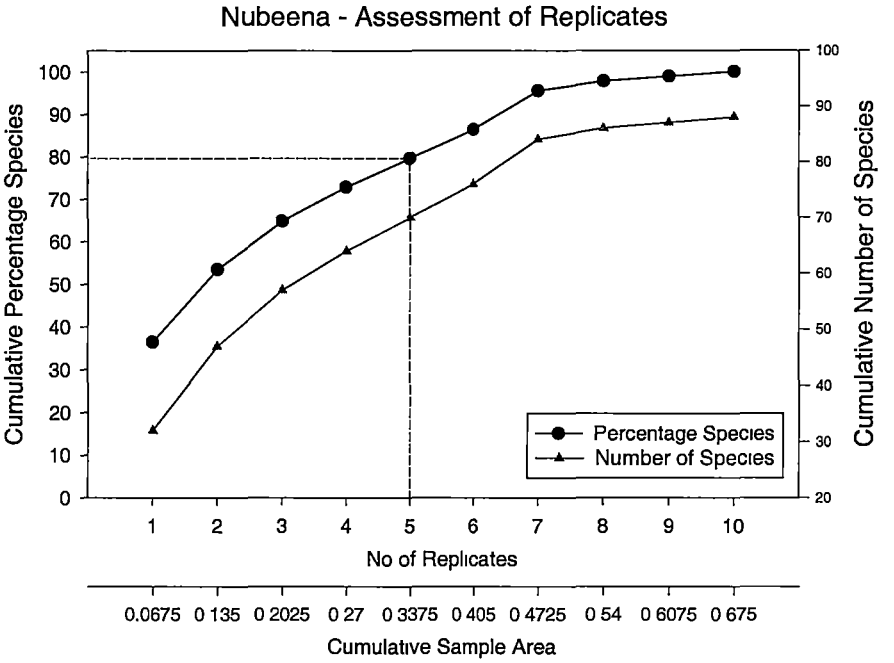
Species		11-Cg1					13-Ref					13-Cg2					13-Cg1					15-Ref					15-Cg2			15-Cg1			
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	d	e	a	c	d	e
25012	Dittosa undecimspinosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
25013	Lophopagurus nanus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25016	Pagurixis handrecki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25020	Litocheira bispinosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25023	Phlyxia intermedia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25027	Upogebia sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25028	Pinnotheres hickmani	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26001	Copepoda sp 1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26002	Copepoda sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27001	Dimorphostylis cottoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
27003	Tasmanomysis oculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27007	Cyclaspis caprella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27015	Leptocuma sp.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27020	Cumacea sp 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29001	Caprella sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29005	Nebalia longicornis	30	23	16	27	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0
29006	Munida haswelli	0	0	0	0	0	0	0	2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
29007	Shrimp sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29008	Leptochela sydniensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29015	Candea sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31001	Zafra atkinsoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
31002	Nassarius nigellus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	4	2	16	42	16	0	0	0	1
31004	Maoricolpus roseus	6	0	1	0	4	18	21	27	6	14	7	0	11	16	21	2	10	2	7	5	1	3	1	6	0	0	0	9	0	0	0	0
31008	Polinices sp 2 (conicus)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31021	Dentimitrella taylorana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31022	Fusinus novaehollandiae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31024	Sinum zonale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32001	Retusa cf pelyx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33004	Opistobranchia sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33008	Opistobranchia sp 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33009	Opistobranchia sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33013	Pleurobranchia maculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34001	Nucula pusilla	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	5	3	6	7	0	1	0	0	0	0	0
34002	Mysella donaciformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34004	Mytilus edulis planulatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1

Species		11-Cg1					13-Ref					13-Cg2					13-Cg1					15-Ref					15-Cg2			15-Cg1			
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	d	e	a	c	d	e
34005	Nemocardium thetidis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	1	1	0	0	0	0	0	0	0	0
34006	Thyasira adelaideana	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	2	0	5	0	0	0	0	0	0	0
34008	Corbula gibba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34009	Theora fragilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	2	0	0	0	0	0	0	0
34010	Hiatella australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34011	Dosinia cf circinata	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
34012	Tellina margaritina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34013	Venericardia bimaculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
34015	Lasea australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34017	Fulvia tenuicostata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34018	Parathyasira resupina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34021	Notocallista diemenensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34026	Solamen cf rex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34031	Amygdalum beddomei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34032	Bassina disjecta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34033	Thracia cf speciosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34035	Venerupis sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34043	Irus carditoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34045	Irus griseus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34046	cf Amygdalum lineum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34047	Myadora brevis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34048	Katelysia scalarina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34049	Solamen recens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
37004	Chiton sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37005	Chiton sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38001	Falcidens sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42004	Asteroidea sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
43001	Amphiura elandiformis	0	0	0	0	0	2	4	3	3	3	0	0	0	0	0	0	0	0	0	0	7	0	5	5	9	0	0	0	0	0	0	0
43009	Ophuroid sp 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43010	Ophiuroid sp 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44001	Echinocardium cordatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	10	0	5	0	11	1	0	0	0	0	0	0	0	0	0
44004	Brissus mendionalis	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52001	Anenome sp 1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	2	4	2	13	0	0	0	0	0	0	0	0
52002	Anenome sp 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52006	Anenome sp 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0

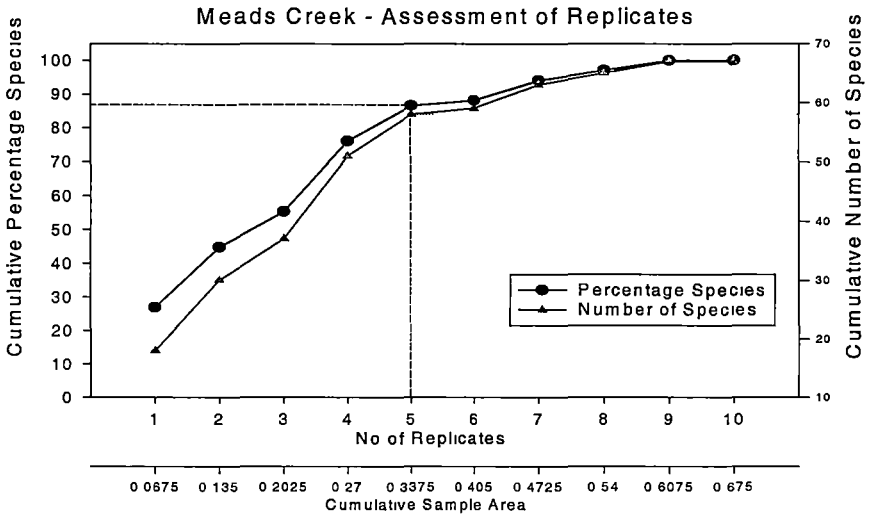
Species		11-Cg1					13-Ref					13-Cg2					13-Cg1					15-Ref					15-Cg2			15-Cg1			
Code	ScientificName	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	b	d	e	a	c	d	e
61003	Platyhelminthes sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62000	Nemertea un-id	0	0	0	0	0	0	2	0	0	1	0	0	2	1	2	0	0	1	0	1	1	1	1	1	1	0	0	0	3	2	1	2
63000	Nematoda un-id	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81001	Sipunculan sp.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81003	Sipunculan sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91003	Ascidea sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94000	Pisces un-id	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94001	Pseudogobias sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94003	Fish sp 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94004	Pisces sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94005	Pisces sp 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96001	Phoronida sp 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96004	Phoronida sp 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDICES 2

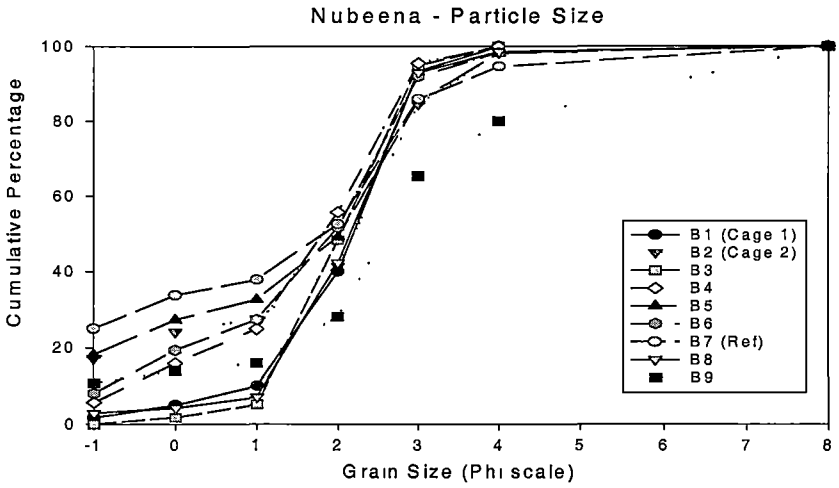
Appendix 2.1: Plot showing cumulative percentage species and cumulative number of species for the number of replicates (cumulative sample area) sampled at Nubeena.



Appendix 2.2: Plot showing cumulative percentage species and cumulative number of species for the number of replicates (cumulative sample area) sampled at Meads Creek.



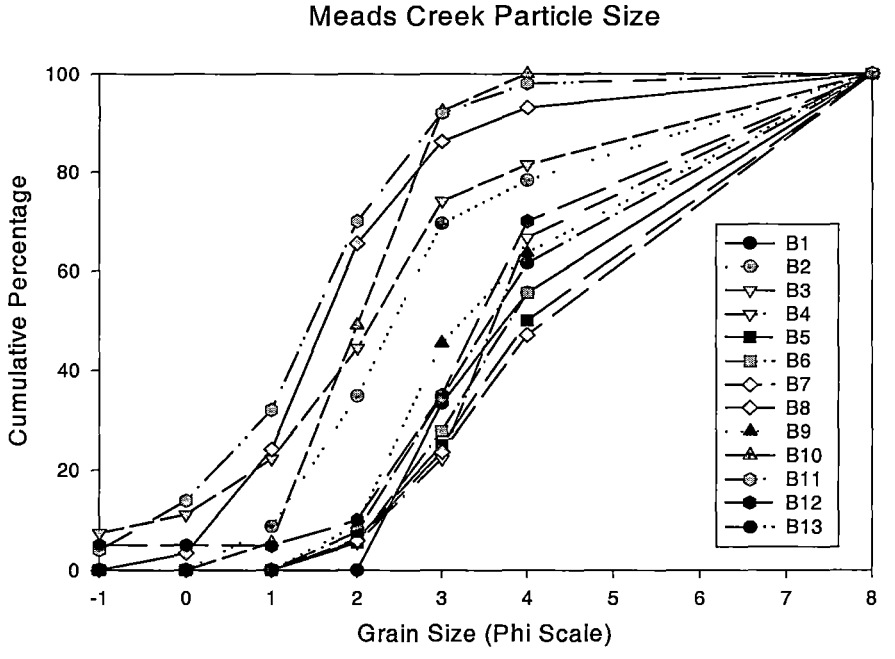
Appendix 2.3: Particle size distribution on the phi scale for the Nubeena spatial survey sample stations



Appendix 2.4: Values for graphic standard deviation and skewness for the baseline stations at Nubeena.

Station	Inclusive Graphic S.D.		Inclusive Graphic Skewness	
1	0.90	Moderately sorted	-0.28	Coarse skewed
2	1.73	Poorly sorted	-0.49	Strongly coarse skewed
3	0.75	Moderately sorted	-0.08	Symmetrical
4	1.3	Poorly sorted	-0.42	Strongly coarse skewed
5	1.73	Poorly sorted	-0.42	Strongly coarse skewed
6	1.47	Poorly sorted	-0.40	Strongly coarse skewed
7	0.89	Moderately sorted	0.27	Fine skewed
8	0.95	Moderately sorted	-0.23	Coarse skewed
9	2.21	Very poorly sorted	0.1	Fine skewed/symmetrical

Appendix 2.5: Particle size distribution on the phi scale for the Meads Creek baseline sample stations.



Appendix 2.6: Values for graphic standard deviation and skewness for the spatial survey stations at Meads Creek.

Station	Inclusive Graphic S.D.		Inclusive Graphic Skewness	
1	1.97	Poorly sorted	0.35	Strongly fine skewed
2	1.91	Poorly sorted	0.36	Strongly fine skewed
3	2.16	Very poorly sorted	0.17	Fine skewed
4	1.76	Very poorly sorted	0.30	Fine skewed
5	2.05	Very poorly sorted	0.18	Fine skewed
6	2.00	Very poorly sorted	0.24	Fine skewed
7	2.07	Very poorly sorted	0.17	Fine skewed
8	1.34	Poorly sorted	0.16	Fine skewed
9	1.96	Poorly sorted	0.35	Strongly fine skewed
10	0.82	Moderately well sorted	0.01	Symmetrical
11	1.32	Poorly sorted	-0.04	Symmetrical
12	1.84	Poorly sorted	0.27	Fine skewed
13	1.93	Poorly sorted	0.34	Fine skewed

Appendix 2.7: Tukey's Post Hoc Test – Spatial Survey - Nubeena Organic Matter

TIME - Tukey HSD Multiple Comparisons.

	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9
ST1	1.000								
ST2	0.664	1.000							
ST3	0.622	0.075	1.000						
ST4	0.324	0.034	0.998	1.000					
ST5	0.999	0.930	0.336	0.155	1.000				
ST6	0.998	0.347	0.921	0.633	0.912	1.000			
ST7	0.857	0.209	1.000	0.998	0.612	0.987	1.000		
ST8	0.428	0.046	1.000	1.000	0.211	0.762	1.000	1.000	
ST9	0.519	0.058	1.000	1.000	0.266	0.849	1.000	1.000	1.000

Appendix 2.8: Tukey's Post Hoc Test – Spatial Survey - Nubeena Surface Redox Potential Measures

TIME - Tukey HSD Multiple Comparisons.

	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9
ST1	1.000								
ST2	0.005	1.000							
ST3	0.495	0.000	1.000						
ST4	0.715	0.000	1.000	1.000					
ST5	0.981	0.001	0.965	0.997	1.000				
ST6	0.406	0.000	1.000	1.000	0.929	1.000			
ST7	0.929	0.000	0.993	1.000	1.000	0.981	1.000		
ST8	0.279	0.000	1.000	0.996	0.827	1.000	0.929	1.000	
ST9	0.183	0.000	0.998	0.974	0.685	1.000	0.827	1.000	1.000

Appendix 2.9: Tukey's Post Hoc Test – Spatial Survey - Nubeena RPD depth Measures

TIME - Tukey HSD Multiple Comparisons.

	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9
ST1	1.000								
ST2	0.033	1.000							
ST3	0.004	0.000	1.000						
ST4	0.000	0.000	0.352	1.000					
ST5	0.000	0.000	0.539	1.000	1.000				
ST6	0.000	0.000	0.739	0.998	1.000	1.000			
ST7	0.000	0.000	0.576	1.000	1.000	1.000	1.000		
ST8	0.000	0.000	0.539	1.000	1.000	1.000	1.000	1.000	
ST9	0.000	0.000	0.539	1.000	1.000	1.000	1.000	1.000	1.000

Appendix 2.10: Tukey's Post Hoc Test – Spatial Survey – Meads Creek Surface Redox Potential Measures

TIME - Tukey HSD Multiple Comparisons.

	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10	ST11	ST12	ST13
ST1	1.000												
ST2	0.003	1.000											
ST3	0.012	1.000	1.000										
ST4	1.000	0.005	0.015	1.000									
ST5	0.112	0.929	0.997	0.140	1.000								
ST6	0.000	0.370	0.156	0.000	0.017	1.000							
ST7	0.000	0.284	0.112	0.000	0.012	1.000	1.000						
ST8	0.000	0.379	0.177	0.000	0.026	1.000	1.000	1.000					
ST9	0.002	1.000	1.000	0.003	0.854	0.486	0.386	0.483	1.000				
ST10	0.000	0.563	0.300	0.000	0.052	1.000	1.000	1.000	0.676	1.000			
ST11	0.000	0.890	0.612	0.000	0.125	0.999	0.995	0.995	0.951	1.000	1.000		
ST12	0.002	1.000	0.999	0.002	0.783	0.576	0.469	0.563	1.000	0.752	0.977	1.000	
ST13	0.001	1.000	0.997	0.001	0.683	0.683	0.576	0.660	1.000	0.833	0.992	1.000	1.000

Appendix 2.11: Tukey's Post Hoc Test – Spatial Survey – Meads Creek RPD depth Measures

TIME - Tukey HSD Multiple Comparisons.

	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10	ST11	ST12	ST13
ST1	1.000												
ST2	0.000	1.000											
ST3	0.000	1.000	1.000										
ST4	1.000	0.000	0.000	1.000									
ST5	0.000	0.999	0.953	0.000	1.000								
ST6	0.000	0.991	1.000	0.000	0.703	1.000							
ST7	0.000	0.991	1.000	0.000	0.703	1.000	1.000						
ST8	0.000	0.997	1.000	0.000	0.822	1.000	1.000	1.000					
ST9	0.000	0.991	1.000	0.000	0.703	1.000	1.000	1.000	1.000				
ST10	0.000	0.997	1.000	0.000	0.822	1.000	1.000	1.000	1.000	1.000			
ST11	0.000	0.991	1.000	0.000	0.703	1.000	1.000	1.000	1.000	1.000	1.000		
ST12	0.000	0.999	1.000	0.000	0.857	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
ST13	0.000	1.000	1.000	0.000	0.991	0.999	0.999	1.000	0.999	1.000	0.999	1.000	1.000

Appendix 2.12: One way ANOSIM for all stations included in the spatial survey at Nubeena.

Sample statistic (Global R): 0.789

Significance level of sample statistic: 0.0%

Groups Used	Statistical Value (R)	Significance Level
(ST1, ST2)	0.644	2.4%
(ST1, ST3)	1.000	0.8%
(ST1, ST4)	0.994	0.8%
(ST1, ST5)	1.000	0.8%
(ST1, ST6)	1.000	0.8%
(ST1, ST7)	0.594	2.9%
(ST1, ST8)	1.000	0.8%
(ST1, ST9)	1.000	0.8%
(ST2, ST3)	0.988	0.8%
(ST2, ST4)	1.000	0.8%
(ST2, ST5)	1.000	0.8%
(ST2, ST6)	1.000	0.8%
(ST2, ST7)	0.819	0.8%
(ST2, ST8)	1.000	0.8%
(ST2, ST9)	1.000	0.8%
(ST3, ST4)	0.628	0.8%
(ST3, ST5)	0.852	0.8%
(ST3, ST6)	0.924	0.8%
(ST3, ST7)	0.063	26.2%
(ST3, ST8)	0.736	0.8%
(ST3, ST9)	0.872	0.8%
(ST4, ST5)	0.824	0.8%
(ST4, ST6)	0.536	0.8%
(ST4, ST7)	0.500	2.4%
(ST4, ST8)	0.560	0.8%
(ST4, ST9)	0.944	0.8%
(ST5, ST6)	0.724	0.8%
(ST5, ST7)	0.588	1.6%
(ST5, ST8)	0.596	0.8%
(ST5, ST9)	0.788	0.8%
(ST6, ST7)	0.531	3.2%
(ST6, ST8)	0.640	0.8%
(ST6, ST9)	0.988	0.8%
(ST7, ST8)	0.475	2.4%
(ST7, ST9)	0.600	0.8%
(ST8, ST9)	0.876	0.8%

Appendix 2.13: One way ANOSIM of a priori defined groupings (1-cage stations, 2-on lease stations and 3-reference stations) for all stations included in the spatial survey at Nubeena.

Sample statistic (Global R): 0.543

Significance level of sample statistic: 0.0%

Groups Used	Statistical Value (R)	Significance Level
(1, 2)	0.892	0.0%
(1, 3)	0.899	0.0%
(2, 3)	0.122	1.7%

Appendix 2.14: SIMPER analysis results indicating the three most important species for all stations in the spatial survey at Nubeena.

Species Name	Average Abundance	Ratio	Percentage	Cumulative % Similarity
Station 1				
Capitella capitata complex	9940.73	18.24	43.26	43.26
Malacoceros tripartitus	348.15	6.36	16.12	59.38
Birubius cartoo	51.85	6.67	9.37	68.75
Station 2				
Capitella capitata complex	678.52	2.87	48.45	48.45
Malacoceros tripartitus	62.22	4.05	43.65	92.10
Ampelisca euroa	5.93	0.32	3.22	95.32
Station 3				
Birubius cartoo	183.70	6.46	10.80	10.80
Euphilomedes sp.(MoV18)	398.52	5.23	10.68	21.49
Dimorphostylis cottoni	183.70	4.53	8.35	29.84
Station 4				
Brolgus tattersalli	219.26	3.69	13.65	13.65
Pista australis	97.78	5.18	12.25	25.90
*Phyllamphicteis sp. (*cf *foliata)*	62.22	1.13	6.60	32.50
Station 5				
Pista australis	1321.48	6.02	17.92	17.92
Mediomastus australiensis	225.19	9.77	11.25	29.16
Theora fragilis	74.07	10.22	8.81	37.98
Station 6				
Pista australis	94.81	4.24	16.07	16.07
Mediomastus australiensis	53.33	3.44	12.91	28.98
Brolgus tattersalli	68.15	1.12	7.75	36.74

Appendix 2.14 (cont): SIMPER analysis results indicating the three most important species for all stations in the spatial survey at Nubeena.

Species Name	Average Abundance	Ratio	Percentage	Cumulative % Similarity
Station 7				
Birubius cartoo	55.56	3.52	21.28	21.28
Archasterope sp. (MoV 1019)	81.48	0.87	13.62	34.90
Cyclaspis caprella	200.00	0.88	12.90	47.80
Station 8				
Pista australis	296.30	6.52	15.38	15.38
Mediomastus australiensis	94.81	7.64	10.65	26.02
Phyllamphicteis sp. (cf foliata)	284.44	1.13	7.68	33.70
Station 9				
Phyllamphicteis sp. (cf foliata)	246.91	6.77	7.24	7.24
Trichobranchidae sp.1	112.59	6.46	6.45	13.69
Dimorphostylis cottoni	121.48	7.01	5.77	19.46

Appendix 2.15: Tukey's Post Hoc Test – Spatial Survey - Nubeena W-statistic

TIME - Tukey HSD Multiple Comparisons.

	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9
ST1	1.000								
ST2	0.390	1.000							
ST3	0.096	0.999	1.000						
ST4	0.053	0.991	1.000	1.000					
ST5	0.646	1.000	0.941	0.836	1.000				
ST6	0.002	0.471	0.806	0.924	0.146	1.000			
ST7	0.007	0.673	0.932	0.983	0.295	1.000	1.000		
ST8	0.060	0.994	1.000	1.000	0.865	0.903	0.975	1.000	
ST9	0.493	1.000	0.985	0.933	1.000	0.237	0.426	0.949	1.000

Appendix 2.16: Tukey's Post Hoc Test – Spatial Survey - Nubeena total number of species.

TIME - Tukey HSD Multiple Comparisons.

	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9
ST1	1.000								
ST2	0.817	1.000							
ST3	0.016	0.000	1.000						
ST4	0.141	0.001	0.985	1.000					
ST5	0.117	0.001	0.992	1.000	1.000				
ST6	0.389	0.007	0.805	0.999	0.998	1.000			
ST7	0.938	0.129	0.294	0.839	0.794	0.988	1.000		
ST8	0.080	0.001	0.998	1.000	1.000	0.992	0.692	1.000	
ST9	0.001	0.000	0.948	0.431	0.489	0.152	0.025	0.609	1.000

Appendix 2.17: Tukey's Post Hoc Test – Spatial Survey - Nubeena number of individuals m^{-2}.

TIME - Tukey HSD Multiple Comparisons.

	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9
ST1	1.000								
ST2	0.000	1.000							
ST3	0.000	0.814	1.000						
ST4	0.000	0.999	0.992	1.000					
ST5	0.000	0.681	1.000	0.968	1.000				
ST6	0.000	1.000	0.808	0.999	0.674	1.000			
ST7	0.000	0.999	0.994	1.000	0.973	0.999	1.000		
ST8	0.000	0.999	0.993	1.000	0.969	0.998	1.000	1.000	
ST9	0.000	0.734	1.000	0.980	1.000	0.727	0.983	0.981	1.000

Appendix 2.18: Tukey's Post Hoc Test – Spatial Survey – Nubeena, Shannon Diversity Indices.

TIME - Tukey HSD Multiple Comparisons.

	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9
ST1	1.000								
ST2	0.419	1.000							
ST3	0.000	0.000	1.000						
ST4	0.000	0.001	1.000	1.000					
ST5	0.000	0.071	0.543	0.771	1.000				
ST6	0.000	0.000	1.000	0.987	0.218	1.000			
ST7	0.000	0.003	1.000	1.000	0.902	0.971	1.000		
ST8	0.000	0.000	1.000	0.999	0.373	1.000	0.996	1.000	
ST9	0.000	0.000	0.869	0.670	0.034	0.994	0.617	0.957	1.000

Appendix 2.19: Tukey's Post Hoc Test – Spatial Survey – Nubeena, Annelida abundance (number m^{-2}).

TIME - Tukey HSD Multiple Comparisons.

	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9
ST1	1.000								
ST2	0.000	1.000							
ST3	0.000	0.989	1.000						
ST4	0.000	0.995	1.000	1.000					
ST5	0.000	1.000	1.000	1.000	1.000				
ST6	0.000	0.971	1.000	1.000	0.998	1.000			
ST7	0.000	0.984	1.000	1.000	0.999	1.000	1.000		
ST8	0.000	0.997	1.000	1.000	1.000	1.000	1.000	1.000	
ST9	0.000	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Appendix 2.20: Tukey's Post Hoc Test – Spatial Survey – Nubeena, Crustacea abundance (number m^{-2}).

TIME - Tukey HSD Multiple Comparisons.

	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9
ST1	1.000								
ST2	0.955	1.000							
ST3	0.078	0.002	1.000						
ST4	0.994	0.452	0.318	1.000					
ST5	1.000	0.912	0.062	0.995	1.000				
ST6	1.000	0.874	0.077	0.998	1.000	1.000			
ST7	0.150	0.006	1.000	0.487	0.130	0.157	1.000		
ST8	1.000	0.845	0.090	0.999	1.000	1.000	0.177	1.000	
ST9	0.995	0.463	0.309	1.000	0.996	0.998	0.476	0.999	1.000

Appendix 2.21: Tukey's Post Hoc Test – Spatial Survey – Nubeena, Mollusca abundance (number m^{-2}).

TIME - Tukey HSD Multiple Comparisons.

	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9
ST1	1.000								
ST2	1.000	1.000							
ST3	1.000	1.000	1.000						
ST4	1.000	1.000	1.000	1.000					
ST5	0.757	0.724	0.856	0.856	1.000				
ST6	1.000	1.000	1.000	1.000	0.826	1.000			
ST7	0.909	0.899	0.963	0.963	1.000	0.951	1.000		
ST8	1.000	1.000	1.000	1.000	0.935	1.000	0.989	1.000	
ST9	0.013	0.008	0.016	0.016	0.373	0.013	0.306	0.027	1.000

Appendix 2.22: One way ANOSIM for all stations included in the spatial survey at Meads Creek.

Sample statistic (Global R): 0.627

Significance level of sample statistic: 0.0%

Groups Used	Stat. Value (R)	Signif. Level	Groups Used	Stat. Value (R)	Signif. Level
(ST1, ST2)	0.748	0 8%	(ST5, ST6)	-0 044	65 9%
(ST1, ST3)	0 720	0.8%	(ST5, ST7)	0.296	7.1%
(ST1, ST4)	0.384	0.8%	(ST5, ST8)	0 608	1.6%
(ST1, ST5)	0.996	0.8%	(ST5, ST9)	0 313	6.3%
(ST1, ST6)	1.000	0.8%	(ST5, ST10)	0 700	0.8%
(ST1, ST7)	0.992	0.8%	(ST5, ST11)	0 596	0 8%
(ST1, ST8)	0.988	0.8%	(ST5, ST12)	0 384	2.4%
(ST1, ST9)	1.000	0.8%	(ST5, ST13)	0.716	0.8%
(ST1, ST10)	0.916	0.8%	(ST6, ST7)	0.528	0 8%
(ST1, ST11)	1.000	0.8%	(ST6, ST8)	0 708	0.8%
(ST1, ST12)	0 976	0.8%	(ST6, ST9)	-0.175	99.2%
(ST1, ST13)	1.000	0.8%	(ST6, ST10)	0 676	0.8%
(ST2, ST3)	0 484	1.6%	(ST6, ST11)	0.628	0.8%
(ST2, ST4)	0.204	12 7%	(ST6, ST12)	0 544	1.6%
(ST2, ST5)	0.464	0.8%	(ST6, ST13)	0.752	0.8%
(ST2, ST6)	0.516	0.8%	(ST7, ST8)	0.820	0 8%
(ST2, ST7)	0.356	1 6%	(ST7, ST9)	0.731	0 8%
(ST2, ST8)	0 656	0.8%	(ST7, ST10)	0.640	0.8%
(ST2, ST9)	0 625	1.6%	(ST7, ST11)	0.948	0.8%
(ST2, ST10)	0 660	0.8%	(ST7, ST12)	0.120	21.4%
(ST2, ST11)	0 636	0.8%	(ST7, ST13)	0.656	0.8%
(ST2, ST12)	0 436	0.8%	(ST8, ST9)	0 713	1.6%
(ST2, ST13)	0 620	0.8%	(ST8, ST10)	0 636	1 6%
(ST3, ST4)	0.460	0.8%	(ST8, ST11)	0 452	0 8%
(ST3, ST5)	0.884	0 8%	(ST8, ST12)	0.792	0 8%
(ST3, ST6)	0.876	0.8%	(ST8, ST13)	0.752	1 6%
(ST3, ST7)	0.768	0.8%	(ST9, ST10)	0.675	0.8%
(ST3, ST8)	0.932	0.8%	(ST9, ST11)	0.675	1.6%
(ST3, ST9)	1 000	0.8%	(ST9, ST12)	0.706	1.6%
(ST3, ST10)	0.824	0.8%	(ST9, ST13)	0 919	0.8%
(ST3, ST11)	0.940	0.8%	(ST10, ST11)	0.840	0.8%
(ST3, ST12)	0 744	0 8%	(ST10, ST12)	0.552	0.8%
(ST3, ST13)	0.956	0.8%	(ST10, ST13)	0.288	0 8%
(ST4, ST5)	0 496	0.8%	(ST11, ST12)	0.820	0.8%
(ST4, ST6)	0 520	0 8%	(ST11, ST13)	0.952	0.8%
(ST4, ST7)	0.476	0 8%	(ST12, ST13)	0 516	0 8%
(ST4, ST8)	0.476	0 8%			
(ST4, ST9)	0 406	3.2%			
(ST4, ST10)	0.440	0.8%			
(ST4, ST11)	0 548	0.8%			
(ST4, ST12)	0.456	1 6%			
(ST4, ST13)	0.468	0.8%			

Appendix 2.23: One way ANOSIM of a priori defined groupings (1-cage stations, 2-on lease stations and 3-reference stations) for all stations included in the spatial survey at Meads Creek.

Sample statistic (Global R): 0.216

Significance level of sample statistic: 0.1%

Groups Used	Statistical Value (R)	Significance Level
(1, 2)	0.261	0.4%
(1, 3)	0.601	0.0%
(2, 3)	0.100	10.7%

Appendix 2.24: Tukey's Post Hoc Test – Spatial Survey - Meads Creek W-statistic

TIME - Tukey HSD Multiple Comparisons.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1 000												
2	0 001	1.000											
3	0.000	1 000	1.000										
4	0.910	0.177	0 091	1.000									
5	0 999	0 017	0.007	1 000	1 000								
6	1.000	0 001	0.000	0.896	0.998	1 000							
7	0 993	0.029	0 012	1 000	1.000	0.990	1.000						
8	1.000	0 001	0 000	0 925	0.999	1.000	0.995	1 000					
9	0.998	0 000	0.000	0 400	0 782	0.999	0 664	0 998	1 000				
10	0 418	0 000	0 000	0 013	0.055	0 444	0 033	0.387	0 979	1 000			
11	1 000	0 002	0 001	0 966	1.000	1 000	0.999	1.000	0.990	0 285	1.000		
12	0.412	0.475	0 287	1 000	0.948	0.387	0.982	0.444	0.073	0 001	0.564	1 000	
13	1.000	0 000	0.000	0 716	0 973	1.000	0 928	1 000	1.000	0.690	1 000	0 199	1.000

Appendix 2.25: Tukey's Post Hoc Test – Spatial Survey - Meads Creek total number of species.

TIME - Tukey HSD Multiple Comparisons.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.000												
2	0.388	1.000											
3	0 809	0 004	1.000										
4	0 086	1.000	0.000	1.000									
5	0 000	0 000	0 026	0.000	1 000								
6	0.042	0 000	0 895	0 000	0.697	1.000							
7	0 970	0.015	1.000	0 002	0.007	0.636	1.000						
8	0 011	0 000	0 636	0 000	0.927	1.000	0 333	1.000					
9	0 060	0.000	0.906	0.000	0 807	1.000	0 673	1.000	1.000				
10	0.970	0.015	1.000	0 002	0 007	0 636	1 000	0 333	0 673	1 000			
11	0.000	0.000	0 086	0 000	1.000	0.927	0.026	0 995	0.965	0 026	1 000		
12	0.855	0 005	1 000	0.000	0.020	0.855	1.000	0.572	0.871	1.000	0 068	1.000	
13	0 132	0 000	0 991	0.000	0 388	1 000	0 895	0.999	1 000	0.895	0 697	0.983	1.000

Appendix 2.26: Tukey's Post Hoc Test – Spatial Survey - Meads Creek number of individuals m^{-2}.

TIME - Tukey HSD Multiple Comparisons.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.000												
2	0.000	1.000											
3	0.000	1.000	1.000										
4	0.798	0.000	0.000	1.000									
5	1.000	0.000	0.000	0.964	1.000								
6	1.000	0.000	0.000	0.922	1.000	1.000							
7	1.000	0.000	0.000	0.888	1.000	1.000	1.000						
8	1.000	0.000	0.000	0.869	1.000	1.000	1.000	1.000					
9	1.000	0.000	0.000	0.923	1.000	1.000	1.000	1.000	1.000				
10	1.000	0.000	0.000	0.803	1.000	1.000	1.000	1.000	1.000	1.000			
11	1.000	0.000	0.000	0.899	1.000	1.000	1.000	1.000	1.000	1.000	1.000		
12	1.000	0.000	0.000	0.918	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
13	1.000	0.000	0.000	0.862	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Appendix 2.27: Tukey's Post Hoc Test – Spatial Survey - Meads Creek, Shannon Diversity Indices.

TIME - Tukey HSD Multiple Comparisons.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.000												
2	0.000	1.000											
3	0.000	1.000	1.000										
4	0.000	0.078	0.345	1.000									
5	0.443	0.000	0.000	0.000	1.000								
6	0.219	0.000	0.000	0.000	1.000	1.000							
7	1.000	0.000	0.000	0.000	0.543	0.291	1.000						
8	0.193	0.000	0.000	0.000	1.000	1.000	0.259	1.000					
9	0.156	0.000	0.000	0.000	1.000	1.000	0.210	1.000	1.000				
10	0.821	0.000	0.000	0.000	1.000	0.998	0.890	0.997	0.987	1.000			
11	0.248	0.000	0.000	0.000	1.000	1.000	0.326	1.000	1.000	0.999	1.000		
12	0.867	0.000	0.000	0.000	0.007	0.002	0.792	0.002	0.002	0.038	0.002	1.000	
13	0.792	0.000	0.000	0.000	1.000	0.999	0.867	0.998	0.990	1.000	1.000	0.033	1.000

Appendix 2.28: Tukey's Post Hoc Test – Spatial Survey – Meads Creek, Annelida abundance (number m^{-2}).

TIME - Tukey HSD Multiple Comparisons.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.000												
2	0.000	1 000											
3	0 793	0.000	1.000										
4	1.000	0.000	0.901	1.000									
5	1.000	0 000	0.797	1 000	1.000								
6	1 000	0 000	0 798	1 000	1.000	1 000							
7	1 000	0.000	0 795	1 000	1.000	1.000	1.000						
8	1.000	0 000	0.797	1 000	1 000	1.000	1.000	1.000					
9	1.000	0 000	0.848	1 000	1.000	1 000	1.000	1 000	1.000				
10	1 000	0.000	0 791	1 000	1.000	1.000	1.000	1.000	1 000	1 000			
11	1.000	0.000	0.793	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		
12	1.000	0 000	0.796	1 000	1 000	1.000	1.000	1 000	1.000	1.000	1 000	1.000	
13	1.000	0 000	0.797	1 000	1.000	1 000	1.000	1 000	1 000	1.000	1 000	1.000	1 000

Appendix 2.29: Tukey's Post Hoc Test – Spatial Survey – Meads Creek, Crustacea abundance (number m^{-2}).

TIME - Tukey HSD Multiple Comparisons.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.000												
2	1 000	1.000											
3	1 000	1.000	1.000										
4	0 004	0 003	0.004	1 000									
5	1.000	1.000	1.000	0.004	1.000								
6	1 000	1.000	1 000	0.004	1 000	1 000							
7	1.000	1 000	1.000	0 004	1.000	1 000	1.000						
8	1.000	1 000	1.000	0 003	1.000	1.000	1.000	1 000					
9	1.000	1.000	1.000	0 007	1.000	1.000	1 000	1 000	1 000				
10	1.000	1.000	1.000	0.003	1 000	1.000	1.000	1.000	1 000	1 000			
11	1.000	1.000	1.000	0 004	1.000	1.000	1.000	1.000	1.000	1.000	1.000		
12	1.000	1.000	1.000	0 003	1.000	1 000	1.000	1 000	1.000	1.000	1.000	1.000	
13	1.000	1.000	1 000	0 004	1.000	1.000	1.000	1 000	1 000	1.000	1 000	1.000	1 000

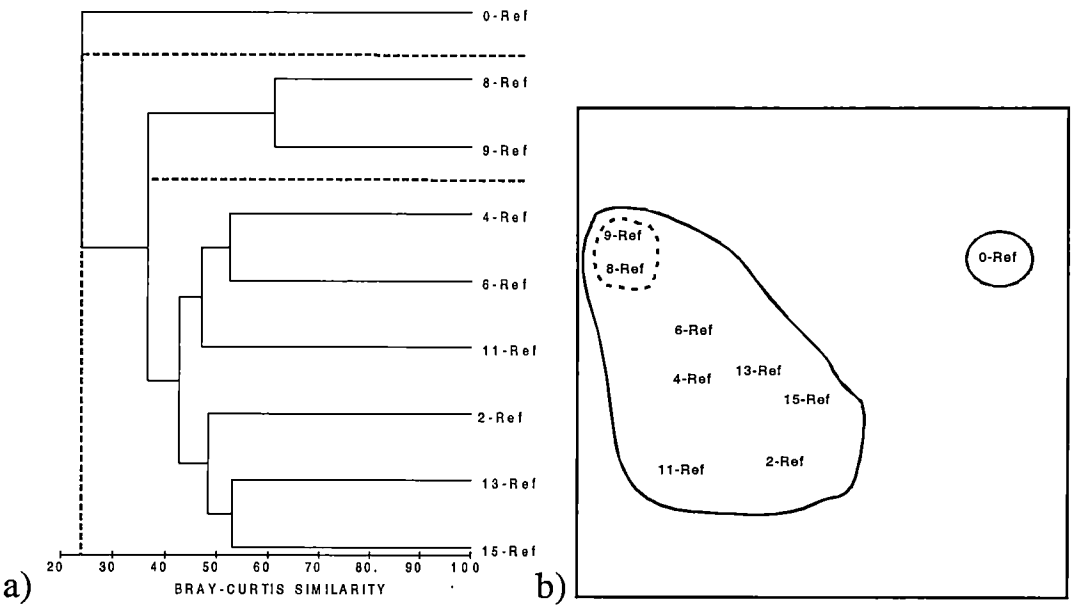
Appendix 2.30: Tukey's Post Hoc Test – Spatial Survey – Meads Creek, Mollusca abundance (number m^{-2}).

TIME - Tukey HSD Multiple Comparisons.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.000												
2	0.991	1 000											
3	1 000	0.997	1.000										
4	1 000	1 000	1 000	1.000									
5	0.168	0 795	0 186	0 785	1.000								
6	0.921	1.000	0.956	0.997	0.958	1.000							
7	0 013	0 175	0 013	0.387	0 997	0.383	1 000						
8	1.000	0.978	1 000	1 000	0.098	0 857	0 006	1 000					
9	0.994	1.000	0.998	1.000	0 856	1.000	0.250	0.985	1 000				
10	1 000	0 999	1 000	1 000	0 279	0 978	0 028	1.000	0.999	1.000			
11	1.000	0.991	1.000	1.000	0.134	0 914	0 008	1 000	0.994	1.000	1.000		
12	0 000	0 003	0.000	0.059	0.315	0.010	0.928	0 000	0.006	0 000	0 000	1 000	
13	1 000	1 000	1 000	1 000	0.353	0.995	0.034	1.000	1.000	1.000	1 000	0 000	1.000

APPENDICES 3

Appendix 3.1: Nubeena reference stations species level identification a) Cluster analysis -Dendrogram b) MDS ordination plot (Stress=0.08). The numbers prefixed to the station identities indicate the time of sampling in months, Chapter 3, table 3.3. All data √√ root transformed and replicates combined.



Appendix 3.2a: Tukey's Post Hoc Test – Nubeena Number of Species - Cage 1

TIME - Tukey HSD Multiple Comparisons.

	0	**2**	**4**	**6**	**9**
0	1.000				
2	1.000	1.000			
4	0.997	0.996	1.000		
6	0.005	0.003	0.002	1.000	
9	0.105	0.074	0.052	0.700	1.000

STATION - Tukey HSD Multiple Comparisons.

	Ref	**Cage1**
Ref	1.000	
Cage1	0.000	1.000

COL/ROW – TIME/STATION - Tukey HSD Multiple Comparisons.

1 0-Ref **6** 4-Cage1
2 0-Cage1 **7** 6-Ref
3 2-Ref **8** 6-Cage1
4 2-Cage1 **9** 9-Ref
5 4-Ref **10** 9-Cage1

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	1.000									
2	0.522	1.000								
3	0.472	0.003	1.000							
4	0.003	0.472	0.000	1.000						
5	0.976	0.090	0.998	0.000	1.000					
6	0.109	0.998	0.000	0.881	0.010	1.000				
7	0.666	1.000	0.004	0.214	0.128	0.969	1.000			
8	0.000	0.046	0.000	0.955	0.000	0.184	0.011	1.000		
9	0.079	0.994	0.000	0.935	0.007	1.000	0.935	0.247	1.000	
10	0.231	1.000	0.000	0.668	0.026	1.000	0.998	0.080	1.000	1.000

Appendix 3.2b: Tukey's Post Hoc Test – Nubeena Number of Species - Cage 2

TIME - Tukey HSD Multiple Comparisons.

	0	**2**	**4**	**6**	**9**	**11**	**13**	**15**
0	1.000							
2	0.003	1.000						
4	0.183	0.903	1.000					
6	1.000	0.003	0.209	1.000				
9	1.000	0.001	0.095	0.999	1.000			
11	1.000	0.001	0.075	1.000	1.000	1.000		
13	0.040	0.983	1.000	0.046	0.018	0.011	1.000	
15	0.001	1.000	0.677	0.001	0.000	0.000	0.854	1.000

STATION - Tukey HSD Multiple Comparisons.

	Ref	**Cage2**
Ref	1.000	
Cage2	0.047	1.000

Appendix 3.2b (cont.):

COL/ROW – TIME/STATION - Tukey HSD Multiple Comparisons.

1	0-Ref	**9**	9-Ref
2	0-Cage2	**10**	9-Cage2
3	2-Ref	**11**	11-Ref
4	2-Cage2	**12**	11-Cage2
5	4-Ref	**13**	13-Ref
6	4-Cage2	**14**	13-Cage2
7	6-Ref	**15**	15-Ref
8	6-Cage2	**16**	15-Cage2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1.000															
2	0.041	1.000														
3	0 952	0 000	1.000													
4	1 000	0 007	0 991	1.000												
5	1.000	0 007	1 000	1.000	1.000											
6	1.000	0 195	0.417	0.996	0 954	1.000										
7	0.987	0 579	0.115	0 869	0.692	1.000	1.000									
8	0.796	0 934	0 020	0 456	0.317	0.994	1.000	1 000								
9	0.576	0.991	0 007	0.248	0.172	0.950	1 000	1.000	1 000							
10	0 946	0.961	0 112	0.768	0.578	1.000	1.000	1.000	1 000	1 000						
11	0 499	0 996	0.005	0 195	0.137	0.915	0.999	1.000	1.000	1.000	1.000					
12	0.952	0 739	0.064	0.739	0.550	1 000	1.000	1.000	1.000	1.000	1.000	1.000				
13	1.000	0 012	0.973	1.000	1.000	0.9999	0.934	0.579	0.343	0.852	0.277	0.840	1.000			
14	1 000	0.003	0.999	1.000	1 000	0.981	0.739	0 309	0 150	0.634	0.115	0 579	1.000	1 000		
15	0.993	0.000	1 000	1.000	1.000	0 692	0.289	0.074	0 030	0 248	0 022	0 185	0.998	1 000	1 000	
16	0.994	0.000	1.000	1.000	1 000	0.661	0.248	0.054	0 020	0 221	0.014	0 150	0.998	1 000	1 000	1.000

Appendix 3.3a: Tukey's Post Hoc Test – Nubeena Total Abundance (number m^{-2}) Cage 1

TIME - Tukey HSD Multiple Comparisons.

	0	**2**	**4**	**6**	**9**
0	1.000				
2	0.000	1.000			
4	0.000	0.654	1.000		
6	0.000	0.065	0.757	1.000	
9	0.000	0.012	0.375	0.958	1.000

STATION - Tukey HSD Multiple Comparisons.

	Ref	**Cage1**
Ref	1.000	
Cage1	0.000	1.000

COL/ROW – TIME/STATION - Tukey HSD Multiple Comparisons.

1 0-Ref **6** 4-Cage1
2 0-Cage1 **7** 6-Ref
3 2-Ref **8** 6-Cage1
4 2-Cage1 **9** 9-Ref
5 4-Ref **10** 9-Cage1

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	1.000									
2	0.000	1.000								
3	1.000	0.000	1.000							
4	0.642	0.000	0.762	1.000						
5	1.000	0.000	0.997	0.370	1.000					
6	0.995	0.000	1.000	0.983	0.909	1.000				
7	0.993	0.000	0.940	0.099	1.000	0.614	1.000			
8	1.000	0.000	0.998	0.267	1.000	0.890	1.000	1.000		
9	0.954	0.000	0.808	0.045	1.000	0.401	1.000	0.997	1.000	
10	0.983	0.000	0.897	0.072	1.000	0.524	1.000	1.000	1.000	1.000

Appendix 3.3b: Tukey's Post Hoc Test – Nubeena Total Abundance (number m^{-2}) Cage 2

TIME - Tukey HSD Multiple Comparisons.

	0	**2**	**4**	**6**	**9**	**11**	**13**	**15**
0	1.000							
2	0.995	1.000						
4	0.999	0.881	1.000					
6	0.566	0.137	0.933	1.000				
9	0.108	0.013	0.403	0.953	1.000			
11	0.184	0.023	0.592	0.996	1.000	1.000		
13	0.964	0.581	1.000	0.989	0.558	0.764	1.000	
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

STATION - Tukey HSD Multiple Comparisons.

	Ref	**Cage2**
Ref	1.000	
Cage2	0.000	1.000

Appendix 3.3b (Cont.):

COL/ROW – TIME/STATION - Tukey HSD Multiple Comparisons.

1	0-Ref	**9**	9-Ref
2	0-Cage2	**10**	9-Cage2
3	2-Ref	**11**	11-Ref
4	2-Cage2	**12**	11-Cage2
5	4-Ref	**13**	13-Ref
6	4-Cage2	**14**	13-Cage2
7	6-Ref	**15**	15-Ref
8	6-Cage2	**16**	15-Cage2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1.000															
2	0.960	1.000														
3	1.000	0.510	1 000													
4	0.995	1.000	0 742	1.000												
5	0 991	1.000	0 765	1.000	1 000											
6	1 000	1.000	0 922	1.000	1.000	1.000										
7	0.615	1.000	0.125	0.999	1.000	0.983	1 000									
8	0 872	1 000	0.321	1 000	1 000	1.000	1 000	1.000								
9	0.170	0 969	0.014	0.865	0.989	0.645	1.000	0.996	1.000							
10	0.569	1 000	0.146	0 994	1.000	0.956	1.000	1.000	1.000	1.000						
11	0.281	0 994	0.030	0.954	0.998	0.810	1.000	1.000	1.000	1.000	1.000					
12	0.610	1 000	0 123	0.999	1 000	0 982	1.000	1.000	1.000	1.000	1.000	1 000				
13	0.769	1.000	0 216	1.000	1 000	0 997	1 000	1 000	0.999	1.000	1 000	1 000	1.000			
14	1 000	1.000	0 909	1 000	1 000	1.000	0.987	1.000	0 671	0 963	0.831	0.986	0 998	1.000		
15	1 000	0.842	1.000	0.956	0 947	0.995	0.383	0.676	0 076	0 368	0 138	0.378	0 539	0.994	1.000	
16	0 000	0.000	0 000	0 000	0.000	0 000	0.000	0.000	0 000	0.000	0 000	0 000	0.000	0 000	0.000	1.000

Appendix 3.4a: Tukey's Post Hoc Test – Nubeena Annelid Abundance (number m^{-2}) Cage 1

TIME - Tukey HSD Multiple Comparisons.

	0	**2**	**4**	**6**	**9**
0	1.000				
2	0.026	1.000			
4	0.000	0.316	1.000		
6	0.000	0.033	0.904	1.000	
9	0.000	0.033	0.431	0.888	1.000

STATION - Tukey HSD Multiple Comparisons.

	Ref	**Cage1**
Ref	1.000	
Cage1	0.000	1.000

COL/ROW – TIME/STATION - Tukey HSD Multiple Comparisons.

1 0-Ref **6** 4-Cage1
2 0-Cage1 **7** 6-Ref
3 2-Ref **8** 6-Cage1
4 2-Cage1 **9** 9-Ref
5 4-Ref **10** 9-Cage1

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	1.000									
2	0.000	1.000								
3	1.000	0.000	1.000							
4	0.001	0.002	0.000	1.000						
5	1.000	0.000	1.000	0.002	1.000					
6	0.348	0.000	0.388	0.189	0.473	1.000				
7	1.000	0.000	1.000	0.000	1.000	0.282	1.000			
8	0.975	0.000	0.990	0.007	0.987	0.937	0.968	1.000		
9	1.000	0.000	1.000	0.000	1.000	0.223	1.000	0.940	1.000	
10	1.000	0.000	1.000	0.000	1.000	0.297	1.000	0.972	1.000	1.000

Appendix 3.4b: Tukey's Post Hoc Test – Nubeena Annelid Abundance (number m^{-2}) Cage 2

TIME - Tukey HSD Multiple Comparisons.

	0	**2**	**4**	**6**	**9**	**11**	**13**	**15**
0	1.000							
2	0.932	1.000						
4	0.999	0.999	1.000					
6	0.996	0.515	0.897	1.000				
9	0.773	0.133	0.447	0.983	1.000			
11	0.976	0.349	0.781	1.000	0.998	1.000		
13	0.999	0.620	0.943	1.000	0.962	1.000	1.000	
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

STATION - Tukey HSD Multiple Comparisons.

	Ref	**Cage2**
Ref	1.000	
Cage2	0.000	1.000

Appendix 3.4b (Cont.):

COL/ROW – TIME/STATION - Tukey HSD Multiple Comparisons.

1	0-Ref	**9**	9-Ref
2	0-Cage2	**10**	9-Cage2
3	2-Ref	**11**	11-Ref
4	2-Cage2	**12**	11-Cage2
5	4-Ref	**13**	13-Ref
6	4-Cage2	**14**	13-Cage2
7	6-Ref	**15**	15-Ref
8	6-Cage2	**16**	15-Cage2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1.000															
2	0 329	1.000														
3	1.000	0 921	1.000													
4	1 000	0 341	1 000	1.000												
5	1 000	0.072	0.997	1.000	1 000											
6	1.000	0 158	1 000	1.000	1.000	1 000										
7	1.000	0.210	1 000	1.000	1 000	1 000	1 000									
8	0 442	1.000	0.953	0.467	0.129	0 249	0.315	1.000								
9	0.977	0 994	1 000	0.987	0.739	0 905	0 946	0.998	1.000							
10	1 000	0.493	1 000	1.000	1.000	1.000	1.000	0.621	0 998	1 000						
11	0.970	0 996	1.000	0 982	0.706	0.885	0.933	0.999	1.000	0 997	1 000					
12	1.000	0 458	1 000	1.000	1.000	1 000	1.000	0.588	0.997	1.000	0.995	1.000				
13	1.000	0 303	1 000	1.000	1 000	1.000	1.000	0 398	0.950	1 000	0 938	1.000	1.000			
14	1.000	0.465	1.000	1 000	1.000	1.000	1.000	0.594	0 997	1 000	0.996	1.000	1.000	1.000		
15	1.000	0.782	1 000	1.000	1 000	0 999	1.000	0 865	1.000	1.000	1.000	1 000	1.000	1 000	1.000	
16	0 000	0.000	0 000	0 000	0.000	0 000	0.000	0.000	0 000	0.000	0.000	0 000	0.000	0 000	0.000	1.000

Appendix 3.5a: Tukey's Post Hoc Test – Nubeena *Capitella capitata* complex abundance (number m^{-2}) - Cage 1

TIME - Tukey HSD Multiple Comparisons.

	0	**2**	**4**	**6**	**9**
0	1.000				
2	0.000	1.000			
4	0.000	0.864	1.000		
6	0.000	0.309	0.919	1.000	
9	0.000	0.073	0.551	0.942	1.000

STATION - Tukey HSD Multiple Comparisons.

	Ref	**Cage1**
Ref	1.000	
Cage1	0.000	1.000

COL/ROW – TIME/STATION - Tukey HSD Multiple Comparisons.

1	0-Ref	**6**	4-Cage1
2	0-Cage1	**7**	6-Ref
3	2-Ref	**8**	6-Cage1
4	2-Cage1	**9**	9-Ref
5	4-Ref	**10**	9-Cage1

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	1.000									
2	0.000	1.000								
3	1.000	0.000	1.000							
4	0.039	0.000	0.017	1.000						
5	1.000	0.000	1.000	0.059	1.000					
6	0.553	0.000	0.403	0.894	0.590	1.000				
7	1.000	0.000	1.000	0.017	1.000	0.392	1.000			
8	0.996	0.000	0.987	0.195	0.995	0.954	0.985	1.000		
9	1.000	0.000	1.000	0.017	1.000	0.392	1.000	0.985	1.000	
10	1.000	0.000	1.000	0.017	1.000	0.392	1.000	0.985	1.000	1.000

Appendix 3.5b: Tukey's Post Hoc Test –Nubeena *Capitella capitata* complex abundance (number m^{-2}) - Cage 2

TIME - Tukey HSD Multiple Comparisons.

	0	**2**	**4**	**6**	**9**	**11**	**13**	**15**
0	1.000							
2	0.520	1.000						
4	0.999	0.891	1.000					
6	0.830	1.000	0.991	1.000				
9	0.574	1.000	0.902	0.999	1.000			
11	0.806	1.000	0.987	1.000	1.000	1.000		
13	0.481	1.000	0.867	0.999	1.000	0.999	1.000	
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

STATION - Tukey HSD Multiple Comparisons.

	Ref	**Cage2**
Ref	1.000	
Cage2	0.000	1.000

Appendix 3.5b (Cont.):

COL/ROW – TIME/STATION - Tukey HSD Multiple Comparisons.

1	0-Ref	**9**	9-Ref
2	0-Cage2	**10**	9-Cage2
3	2-Ref	**11**	11-Ref
4	2-Cage2	**12**	11-Cage2
5	4-Ref	**13**	13-Ref
6	4-Cage2	**14**	13-Cage2
7	6-Ref	**15**	15-Ref
8	6-Cage2	**16**	15-Cage2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1 000															
2	0 795	1.000														
3	1 000	0 490	1.000													
4	1 000	0.475	1.000	1.000												
5	1 000	0 688	1.000	1 000	1 000											
6	0.961	1 000	0.795	0 782	0.902	1 000										
7	1.000	0 453	1.000	1 000	1.000	0 762	1.000									
8	1 000	0 931	1 000	1 000	1.000	0 996	1 000	1 000								
9	1.000	0.453	1 000	1.000	1.000	0 762	1 000	1.000	1.000							
10	1.000	0.688	1.000	1.000	1 000	0 902	1 000	1.000	1.000	1 000						
11	1 000	0.460	1 000	1.000	1 000	0.769	1 000	1.000	1.000	1 000	1 000					
12	1.000	0.905	1.000	1.000	1.000	0.992	1.000	1.000	1 000	1 000	1 000	1.000				
13	1 000	0.453	1.000	1.000	1 000	0.762	1.000	1.000	1.000	1 000	1 000	1.000	1 000			
14	1.000	0453	1 000	1.000	1.000	0.762	1.000	1.000	1.000	1 000	1.000	1 000	1.000	1.000		
15	1 000	0.672	1.000	1.000	1 000	0 906	1.000	1.000	1.000	1 000	1.000	1.000	1.000	1.000	1.000	
16	0 000	0.000	0.000	0.000	0.000	0 000	0.000	0.000	0 000	0.000	0.000	0 000	0.000	0 000	0.000	1.000

Appendix 3.6a: Tukey's Post Hoc Test – Nubeena sediment surface redox potential - Cage 1

TIME - Tukey HSD Multiple Comparisons.

	0	**2**	**4**	**6**	**9**
0	1.000				
2	0.027	1.000			
4	0.362	0.000	1.000		
6	0.176	0.870	0.004	1.000	
9	0.033	0.000	0.679	0.000	1.000

STATION - Tukey HSD Multiple Comparisons.

	Ref	**Cage1**
Ref	1.000	
Cage1	0.000	1.000

COL/ROW – TIME/STATION - Tukey HSD Multiple Comparisons.

1	0-Ref	**6**	4-Cage1
2	0-Cage1	**7**	6-Ref
3	2-Ref	**8**	6-Cage1
4	2-Cage1	**9**	9-Ref
5	4-Ref	**10**	9-Cage1

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	1.000									
2	0.856	1.000								
3	1.000	0.970	1.000							
4	0.000	0.011	0.001	1.000						
5	0.959	0.209	0.826	0.000	1.000					
6	1.000	0.906	1.000	0.000	0.927	1.000				
7	0.906	0.149	0.723	0.000	1.000	0.856	1.000			
8	0.000	0.004	0.000	1.000	0.000	0.000	0.000	1.000		
9	0.927	0.167	0.759	0.000	1.000	0.882	1.000	0.000	1.000	
10	0.826	0.104	0.606	0.000	1.000	0.759	1.000	0.000	1.000	1.000

Appendix 3.6b: Tukey's Post Hoc Test – Nubeena sediment surface redox potential - Cage 2

TIME - Tukey HSD Multiple Comparisons.

	0	**2**	**4**	**6**	**9**	**11**	**13**	**15**
0	1.000							
2	0.413	1.000						
4	0.038	0.921	1.000					
6	0.000	0.006	0.114	1.000				
9	0.000	0.000	0.003	0.798	1.000			
11	0.000	0.017	0.241	1.000	0.564	1.000		
13	0.000	0.000	0.006	0.921	1.000	0.745	1.000	
15	0.000	0.000	0.000	0.413	0.998	0.221	0.981	1.000

STATION - Tukey HSD Multiple Comparisons.

	Ref	**Cage2**
Ref	1.000	
Cage2	0.000	1.000

Appendix 3.6b (Cont.):

COL/ROW – TIME/STATION - Tukey HSD Multiple Comparisons.

1	0-Ref	**9**	9-Ref
2	0-Cage2	**10**	9-Cage2
3	2-Ref	**11**	11-Ref
4	2-Cage2	**12**	11-Cage2
5	4-Ref	**13**	13-Ref
6	4-Cage2	**14**	13-Cage2
7	6-Ref	**15**	15-Ref
8	6-Cage2	**16**	15-Cage2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1.000															
2	0 000	1.000														
3	1 000	0 000	1 000													
4	0.013	0.093	0.036	1.000												
5	0 993	0.000	0 926	0.000	1.000											
6	0 013	0.093	0 036	1.000	0 000	1 000										
7	0.973	0.000	0.846	0 000	1.000	0 000	1 000									
8	1.000	0.000	1.000	0.036	0.926	0 036	0 846	1 000								
9	0 982	0.000	0.877	0 000	1.000	0 000	1.000	0.877	1.000							
10	0 904	0.000	0.691	0.000	1.000	0.000	1.000	0 691	1.000	1 000						
11	0 926	0 000	0 734	0.000	1.000	0.000	1.000	0.734	1 000	1.000	1.000					
12	0 998	0 000	1.000	0.188	0 512	0.188	0.384	1.000	1.000	1.000	0.275	1.000				
13	0 999	0.000	0.973	0.001	1.000	0.001	1.000	0.973	0 425	0.243	1.000	0.647	1.000			
14	0 926	0.000	0.734	0.000	1 000	0 000	1.000	0.734	1.000	1.000	1.000	0.275	1.000	1.000		
15	0 774	0.000	0.512	0.000	1.000	0 000	1.000	0.512	1.000	1.000	1.000	0.143	1.000	1.000	1.000	
16	0 774	0.000	0.512	0 000	1.000	0 000	1.000	0.512	1.000	1.000	1.000	0.143	1 000	1.000	1.000	1.000

Appendix 3.7a: Tukey's Post Hoc Test – Nubeena RPD depth measure - Cage 1

TIME - Tukey HSD Multiple Comparisons.

	0	**2**	**4**	**6**	**9**
0	1.000				
2	0.198	1.000			
4	1.000	0.198	1.000		
6	0.276	1.000	0.276	1.000	
9	0.094	0.001	0.094	0.001	1.000

STATION - Tukey HSD Multiple Comparisons.

	Ref	**Cage1**
Ref	1.000	
Cage1	0.000	1.000

COL/ROW – TIME/STATION - Tukey HSD Multiple Comparisons.

1 0-Ref **6** 4-Cage1
2 0-Cage1 **7** 6-Ref
3 2-Ref **8** 6-Cage1
4 2-Cage1 **9** 9-Ref
5 4-Ref **10** 9-Cage1

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	1.000									
2	0.000	1.000								
3	1.000	0.000	1.000							
4	0.000	0.097	0.000	1.000						
5	1.000	0.001	1.000	0.000	1.000					
6	0.001	1.000	0.001	0.030	0.002	1.000				
7	1.000	0.000	1.000	0.000	0.996	0.000	1.000			
8	0 000	0.097	0.000	1.000	0.000	0.030	0.000	1.000		
9	0.996	0.001	0.996	0.000	1.000	0.005	0.970	0.000	1.000	
10	0.894	0.005	0.894	0.000	0.996	0.016	0.758	0.000	1.000	1.000

Appendix 3.7b: Tukey's Post Hoc Test – Nubeena RPD depth measure - Cage 2

TIME - Tukey HSD Multiple Comparisons.

	0	**2**	**4**	**6**	**9**	**11**	**13**	**15**
0	1.000							
2	0.983	1.000						
4	1.000	0.997	1.000					
6	0.002	0.019	0.003	1.000				
9	0.000	0.000	0.000	0.335	1.000			
11	0.002	0.019	0.003	1.000	0.335	1.000		
13	0.000	0.002	0.000	0.983	0.865	0.983	1.000	
15	0.466	0.943	0.610	0.229	0.001	0.229	0.033	1.000

STATION - Tukey HSD Multiple Comparisons.

	Ref	**Cage2**
Ref	1.000	
Cage2	0.000	1.000

Appendix 3.7b (Cont.):

COL/ROW – TIME/STATION - Tukey HSD Multiple Comparisons.

1	0-Ref	**9**	9-Ref
2	0-Cage2	**10**	9-Cage2
3	2-Ref	**11**	11-Ref
4	2-Cage2	**12**	11-Cage2
5	4-Ref	**13**	13-Ref
6	4-Cage2	**14**	13-Cage2
7	6-Ref	**15**	15-Ref
8	6-Cage2	**16**	15-Cage2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1 000															
2	0 000	1.000														
3	1.000	0 000	1.000													
4	0.000	0.994	0.000	1.000												
5	1.000	0 000	1.000	0 000	1.000											
6	0.000	1 000	0.000	1.000	0.000	1.000										
7	1.000	0.000	1.000	0.000	1.000	0 000	1 000									
8	0 015	0.000	0.015	0 003	0 073	0 001	0 007	1.000								
9	1 000	0.000	1.000	0 000	1 000	0.000	0 994	0.145	1 000							
10	1.000	0.000	1.000	0.000	1 000	0 000	1.000	0.007	0.994	1.000						
11	0.994	0 000	0 994	0.000	1.000	0.000	0.954	0.268	1.000	0 954	1 000					
12	0.445	0 000	0.445	0.000	0.842	0.000	0.268	0 954	0.954	0.268	0.994	1 000				
13	1.000	0 000	1 000	0 000	1.000	0.000	1 000	0 007	0.994	1.000	0.954	0.268	1.000			
14	0.268	0 000	0.268	0.000	0.655	0.000	0.145	0 994	0.842	0.145	0.954	1.000	0.145	1 000		
15	1.000	0 000	1.000	0 000	1.000	0.000	0.994	0 145	1.000	0.994	1.000	0.954	0.994	0.842	1.000	
16	0 000	0.034	0 000	0.445	0.000	0.268	0 000	0.655	0 000	0.000	0 001	0 034	0.000	0.073	0.000	1.000

Appendix 3.8: Tukey's Post Hoc Test – Meads Creek Number of Species

TIME - Tukey HSD Multiple Comparisons.

	0	**2**	**4**	**6**	**9**	**11**	**13**	**15**
0	1.000							
2	0.514	1.000						
4	1.000	0.696	1.000					
6	0.043	0.000	0.027	1.000				
9	0.868	0.030	0.765	0.674	1.000			
11	0.000	0.000	0.000	0.514	0.010	1.000		
13	0.000	0.000	0.000	0.421	0.006	1.000	1.000	
15	0.836	0.032	0.729	0.806	1.000	0.027	0.018	1.000

STATION - Tukey HSD Multiple Comparisons.

	Ref	**Cage1**	**Cage2**
Ref	1.000		
Cage1	0.000	1.000	
Cage2	0.000	0.000	1.000

Appendix 3.8 (Cont.):

COL/ROW – TIME/STATION - Tukey HSD Multiple Comparisons.

1	0-Ref	**9**	4-Cage2	**17**	11-Cage1
2	0-Cage1	**10**	6-Ref	**18**	11-Cage2
3	0-Cage2	**11**	6-Cage1	**19**	13-Ref
4	2-Ref	**12**	6-Cage2	**20**	13-Cage1
5	2-Cage1	**13**	9-Ref	**21**	13-Cage2
6	2-Cage2	**14**	9-Cage1	**22**	15-Ref
7	4-Ref	**15**	9-Cage2	**23**	15-Cage1
8	4-Cage1	**16**	11-Ref	**24**	15-Cage2

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000											
2	0 004	1.000										
3	0 000	0.841	1 000									
4	0.962	0.562	0 001	1.000								
5	0 000	0.440	1 000	0 000	1.000							
6	1.000	0.000	0 000	0 196	0.000	1.000						
7	0.794	0.841	0.005	1.000	0.001	0.068	1 000					
8	0 000	0 196	1.000	0 000	1.000	0.000	0 000	1 000				
9	1 000	0.097	0.000	1.000	0.000	0 929	0.999	0.000	1.000			
10	0 005	1 000	0 794	0 624	0.383	0 000	0 882	0 162	0.119	1.000		
11	0 000	0 915	1.000	0.002	1 000	0 000	0.008	1.000	0.000	0 882	1 000	
12	0 000	1 000	1 000	0 042	0.992	0 000	0 132	0.915	0.003	1.000	1.000	1 000
	1	2	3	4	5	6	7	8	9	10	11	12
13	0.033	1.000	0.383	0.942	0.107	0.000	0.996	0.033	0 389	1 000	0.500	0.976
14	0 000	1 000	1.000	0 048	0.999	0.000	0 138	0 982	0 004	1 000	1 000	1.000
15	0 025	1 000	0.440	0.915	0 132	0 000	0.992	0 042	0 338	1 000	0 562	0 986
16	0.004	1.000	0.841	0 562	0 440	0 000	0.841	0 196	0 097	1 000	0.915	1 000
17	0 000	0 329	1 000	0.000	1.000	0.000	0 000	1.000	0.000	0.280	1 000	0 976
18	0.000	0.086	1.000	0 000	1 000	0.000	0 000	1 000	0 000	0.068	0.998	0 742
19	0 000	1 000	1.000	0.033	0.996	0 000	0 107	0.942	0.002	1.000	1.000	1.000
20	0.000	0 383	1 000	0.000	1.000	0 000	0 000	1.000	0.000	0.329	1.000	0.986
21	0 000	0 562	1 000	0 000	1.000	0 000	0.001	1.000	0.000	0 500	1.000	0.998
22	1.000	0 068	0 000	1.000	0.000	0.841	0 999	0.000	1 000	0.086	0.000	0.001
23	0.000	0 780	1 000	0.001	1.000	0.000	0 005	1.000	0 000	0 729	1.000	1.000
24	0.000	1 000	1 000	0 075	1.000	0.000	0 186	0.998	0 007	0 999	1.000	1 000
	13	14	15	16	17	18	19	20	21	22	23	24
13	1.000											
14	0.964	1.000										
15	1 000	0 977	1 000									
16	1.000	1.000	1.000	1.000								
17	0.068	0.997	0.086	0 329	1.000							
18	0 011	0.908	0.015	0 086	1 000	1.000						
19	0 962	1.000	0.976	1 000	0 986	0.794	1 000					
20	0 086	0 999	0.107	0 383	1 000	1 000	0.992	1 000				
21	0.162	1 000	0 196	0.862	1.000	1 000	0.999	1.000	1.000			
22	0 329	0.002	0.280	0.068	0 000	0.000	0.001	0.000	0 000	1 000		
23	0 338	1 000	0 389	0.780	1 000	1 000	1.000	1.000	1 000	0 000	1.000	
24	0.965	1.000	0.977	1.000	1 000	0.983	1 000	1 000	1 000	0.005	1.000	1 000

Appendix 3.9: Tukey's Post Hoc Test – Meads Creek Total Abundance (number m^{-2})

TIME - Tukey HSD Multiple Comparisons.

	0	**2**	**4**	**6**	**9**	**11**	**13**	**15**
0	1.000							
2	0.000	1.000						
4	0.000	1.000	1.000					
6	0.000	0.989	0.993	1.000				
9	0.000	1.000	1.000	0.953	1.000			
11	0.000	1.000	1.000	0.998	1.000	1.000		
13	0.000	1.000	1.000	0.999	0.999	1.000	1.000	
15	0.000	0.680	0.278	0.206	0.844	0.543	0.506	1.000

STATION - Tukey HSD Multiple Comparisons.

	Ref	**Cage1**	**Cage2**
Ref	1.000		
Cage1	0.884	1.000	
Cage2	0.000	0.000	1.000

COL/ROW – TIME/STATION - Tukey HSD Multiple Comparisons.

1	0-Ref	**9**	4-Cage2	**17**	11-Cage1
2	0-Cage1	**10**	6-Ref	**18**	11-Cage2
3	0-Cage2	**11**	6-Cage1	**19**	13-Ref
4	2-Ref	**12**	6-Cage2	**20**	13-Cage1
5	2-Cage1	**13**	9-Ref	**21**	13-Cage2
6	2-Cage2	**14**	9-Cage1	**22**	15-Ref
7	4-Ref	**15**	9-Cage2	**23**	15-Cage1
8	4-Cage1	**16**	11-Ref	**24**	15-Cage2

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	1.000											
2	1.000	1.000										
3	0.000	0 000	1.000									
4	1.000	1.000	0.000	1 000								
5	1.000	1.000	0.000	1.000	1.000							
6	1.000	1.000	0.000	1.000	1.000	1 000						
7	1.000	1.000	0 000	1 000	1 000	1.000	1.000					
8	1.000	1.000	0.000	1.000	1.000	1.000	1.000	1.000				
9	1.000	1.000	0.000	1.000	1 000	1.000	1 000	1.000	1.000			
10	1.000	1.000	0.000	1.000	1 000	1.000	1 000	1.000	1 000	1.000		
11	1.000	1.000	0.000	1.000	1.000	1.000	1 000	1.000	1.000	1 000	1.000	
12	1.000	1 000	0 000	1.000	1.000	1 000	1 000	1.000	1 000	1.000	1.000	1.000

Appendix 3.9 (Cont.):

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
13	1 000	1.000	0.000	1 000	1.000	1.000	1.000	1.000	1 000	1.000	1 000	1 000
14	1.000	1.000	0.000	1 000	1.000	1 000	1 000	1.000	1.000	1.000	1 000	1 000
15	1.000	1 000	0.000	1.000	1.000	1 000	1 000	1.000	1.000	1 000	1 000	1.000
16	1.000	1 000	0 000	1.000	1.000	1 000	1 000	1 000	1.000	1.000	1 000	1 000
17	1.000	1.000	0 000	1 000	1.000	1 000	1 000	1 000	1.000	1.000	1 000	1.000
18	1.000	1.000	0 000	1.000	1.000	1 000	1 000	1.000	1.000	1 000	1 000	1 000
19	1.000	1.000	0 000	1.000	1.000	1 000	1.000	1.000	1.000	1 000	1.000	1 000
20	1.000	1.000	0.000	1.000	1 000	1.000	1.000	1.000	1.000	1.000	1.000	1 000
21	1.000	1 000	0.000	1.000	1 000	1 000	1 000	1.000	1.000	1 000	1.000	1 000
22	1 000	1.000	0 000	1.000	1.000	1 000	1 000	1 000	1.000	1.000	1.000	1 000
23	1.000	1.000	0 000	1 000	1.000	1 000	1 000	1 000	1.000	1.000	1.000	1 000
24	0 329	0.153	0 000	0 248	0.211	0.609	0.199	0 548	0.359	0.139	0.142	0.116
	13	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
13	1 000											
14	1.000	1.000										
15	1 000	1.000	1.000									
16	1.000	1.000	1 000	1.000								
17	1.000	1 000	1.000	1.000	1 000							
18	1 000	1.000	1 000	1 000	1.000	1 000						
19	1 000	1 000	1.000	1 000	1 000	1.000	1.000					
20	1.000	1 000	1.000	1.000	1 000	1 000	1.000	1.000				
21	1 000	1.000	1.000	1 000	1.000	1.000	1 000	1 000	1.000			
22	1.000	1 000	1.000	1.000	1.000	1 000	1.000	1.000	1.000	1.000		
23	1 000	1.000	1.000	1 000	1.000	1.000	1 000	1 000	1.000	1.000	1 000	
24	0.360	0 840	0.205	0.146	0.551	0 197	0 175	0.119	0.590	0 295	0 332	1.000

Appendix 3.10: Tukey's Post Hoc Test – Meads Creek Annelid Abundance (number m^{-2})

TIME (Month) - Tukey HSD Multiple Comparisons.

	0	**2**	**4**	**6**	**9**	**11**	**13**	**15**
0	1.000							
2	0.000	1.000						
4	0.000	1.000	1.000					
6	0.000	0.992	0.999	1.000				
9	0.000	1.000	1.000	0.998	1.000			
11	0.000	1.000	1.000	0.999	1.000	1.000		
13	0.000	1.000	1.000	1.000	1.000	1.000	1.000	
15	0.000	0.817	0.686	0.320	0.741	0.660	0.605	1.000

STATION - Tukey HSD Multiple Comparisons.

	Ref	**Cage1**	**Cage2**
Ref	1.000		
Cage1	0.660	1.000	
Cage2	0.000	0.000	1.000

Appendix 3.10 (Cont.):

COL/ROW – TIME/STATION - Tukey HSD Multiple Comparisons.

1	0-Ref	**9**	4-Cage2	**17**	11-Cage1
2	0-Cage1	**10**	6-Ref	**18**	11-Cage2
3	0-Cage2	**11**	6-Cage1	**19**	13-Ref
4	2-Ref	**12**	6-Cage2	**20**	13-Cage1
5	2-Cage1	**13**	6-Ref	**21**	13-Cage2
6	2-Cage2	**14**	6-Cage1	**22**	15-Ref
7	4-Ref	**15**	6-Cage2	**23**	15-Cage1
8	4-Cage1	**16**	11-Ref	**24**	15-Cage2

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	1.000											
2	0 000	1.000										
3	1.000	0.000	1.000									
4	1.000	0.000	1.000	1.000								
5	1.000	0.000	1.000	1.000	1.000							
6	1 000	0.000	1 000	1.000	1 000	1.000						
7	1 000	0.000	1 000	1.000	1 000	1.000	1 000					
8	1.000	0.000	1.000	1.000	1.000	1.000	1 000	1 000				
9	1.000	0 000	1.000	1 000	1.000	1 000	1.000	1 000	1.000			
10	1.000	0.000	1 000	1.000	1 000	1.000	1 000	1.000	1 000	1.000		
11	1.000	0 000	1.000	1 000	1.000	1 000	1.000	1 000	1 000	1 000	1 000	
12	1 000	0.000	1 000	1.000	1 000	1 000	1 000	1 000	1.000	1.000	1.000	1 000
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
13	1.000	0.000	1.000	1 000	1.000	1 000	1.000	1.000	1.000	1.000	1.000	1 000
14	1 000	0.000	1 000	1.000	1 000	1.000	1 000	1.000	1 000	1.000	1.000	1 000
15	1.000	0 000	1.000	1.000	1.000	1.000	1.000	1 000	1.000	1 000	1.000	1 000
16	1.000	0 000	1.000	1.000	1 000	1.000	1 000	1.000	1.000	1.000	1 000	1.000
17	1 000	0.000	1 000	1.000	1.000	1.000	1 000	1.000	1 000	1.000	1 000	1.000
18	1 000	0 000	1 000	1 000	1 000	1 000	1 000	1.000	1.000	1 000	1 000	1.000
19	1.000	0 000	1.000	1.000	1.000	1 000	1.000	1 000	1.000	1 000	1.000	1 000
20	1.000	0 000	1.000	1.000	1 000	1.000	1.000	1 000	1 000	1.000	1.000	1 000
21	1 000	0.000	1 000	1.000	1 000	1.000	1.000	1.000	1 000	1 000	1.000	1 000
22	1.000	0.000	1.000	1 000	1 000	1 000	1 000	1.000	1.000	1.000	1 000	1.000
23	1.000	0 000	1.000	1.000	1.000	1 000	1.000	1.000	1.000	1 000	1 000	1.000
24	1.000	0.000	1 000	1.000	1.000	1 000	1 000	1 000	1.000	1 000	1.000	1.000
	13	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
13	1.000											
14	1.000	1.000										
15	1.000	1 000	1.000									
16	1.000	1.000	1 000	1.000								
17	1.000	1.000	1.000	1 000	1.000							
18	1.000	1 000	1.000	1.000	1.000	1.000						
19	1 000	1 000	1.000	1.000	1 000	1.000	1 000					
20	1.000	1 000	1.000	1 000	1 000	1 000	1 000	1.000				
21	1.000	1.000	1.000	1 000	1.000	1 000	1.000	1.000	1 000			
22	1.000	1.000	1.000	1.000	1.000	1 000	1.000	1.000	1.000	1 000		
23	1.000	1.000	1.000	1 000	1.000	1 000	1.000	1 000	1.000	1 000	1 000	
24	1 000	1.000	1.000	1 000	1 000	1 000	1.000	1.000	1.000	1.000	1 000	1.000

Appendix 3.11: Tukey's Post Hoc Test – Meads Creek Abundance (number m^{-2}) of *Capitella capitata* complex.

- Exactly the same time matrix as for total annelid abundance

STATION - Tukey HSD Multiple Comparisons.

	Ref	Cage1	Cage2
Ref	1.000		
Cage1	0.788	1.000	
Cage2	0.000	0.000	1.000

- Exactly the same pairwise output as for total annelid abundance

Appendix 3.12: Tukey's Post Hoc Test – Meads Creek Surface Redox Potential

TIME - Tukey HSD Multiple Comparisons.

	0	2	4	6	9	11	13	15
0	1.000							
2	0.652	1.000						
4	0.350	0.006	1.000					
6	0.064	0.000	0.996	1.000				
9	0.960	0.113	0.925	0.491	1.000			
11	0.073	0.909	0.000	0.000	0.004	1.000		
13	0.952	0.104	0.936	0.515	1.000	0.004	1.000	
15	0.909	1.000	0.025	0.002	0.301	0.652	0.282	1.000

STATION - Tukey HSD Multiple Comparisons.

	Ref	Cage1	Cage2
Ref	1.000		
Cage1	0.000	1.000	
Cage2	0.000	0.000	1.000

COL/ROW – TIME/STATION - Tukey HSD Multiple Comparisons.

1	0-Ref	**9**	4-Cage2	**17**	11-Cage1
2	0-Cage1	**10**	6-Ref	**18**	11-Cage2
3	0-Cage2	**11**	6-Cage1	**19**	13-Ref
4	2-Ref	**12**	6-Cage2	**20**	13-Cage1
5	2-Cage1	**13**	9-Ref	**21**	13-Cage2
6	2-Cage2	**14**	9-Cage1	**22**	15-Ref
7	4-Ref	**15**	9-Cage2	**23**	15-Cage1
8	4-Cage1	**16**	11-Ref	**24**	15-Cage2

	1	2	3	4	5	6	7	8	9	10	11	12
1	1 000											
2	0.000	1 000										
3	0 953	0 000	1 000									
4	0.977	0 000	1.000	1.000								
5	0.000	1.000	0.002	0 001	1.000							
6	0.063	0.075	0.966	0.935	0.277	1.000						
7	0.994	0.000	0.120	0 162	0.000	0.001	1 000					
8	0.000	0.953	0 088	0.063	0 999	0 977	0 000	1 000				
9	1.000	0.000	1 000	1 000	0 002	0 883	0 559	0.071	1 000			
10	1.000	0 000	0.434	0 524	0.000	0.005	1.000	0 000	0.907	1 000		
11	0 000	1.000	0.008	0.006	1.000	0 570	0 000	1.000	0 008	0 000	1 000	
12	0.999	0 000	0 174	0.228	0 000	0 001	1.000	0 000	0 662	1.000	0.000	1 000

Appendix 3.12 (Cont.):

	1	2	3	4	5	6	7	8	9	10	11	12
13	1 000	0 000	0 391	0 478	0 000	0.004	1.000	0.000	0 883	1 000	0 000	1 000
14	0 001	0.889	0.140	0.103	0 996	0 994	0 000	1.000	0.109	0 000	1 000	0.000
15	0.224	0.015	1 000	0 999	0 075	1.000	0 004	0 750	0 994	0 026	0.214	0.006
16	1.000	0 000	0.391	0.478	0.000	0.004	1 000	0 000	0 883	1.000	0.000	1 000
17	0.000	1 000	0.000	0 000	1.000	0.053	0.000	0 914	0.000	0 000	1.000	0 000
18	0.000	1 000	0 000	0.000	1 000	0.018	0.000	0.707	0.000	0.000	0.994	0 000
19	1.000	0 000	0.391	0.478	0 000	0 004	1 000	0.000	0.883	1 000	0 000	1.000
20	0 001	0 790	0 214	0.162	0.985	0.999	0 000	1.000	0.162	0.000	1.000	0.000
21	0 186	0.022	0.999	0.996	0 103	1 000	0 002	0.826	0.985	0.018	0 277	0.004
22	0.001	0 000	0 277	0.350	0.000	0.002	1 000	0 000	0 794	1.000	0.000	1.000
23	0 000	0 966	0.075	0.053	1 000	0 966	0.000	1.000	0 061	0 000	1 000	0 000
24	0.000	1 000	0.001	0.001	1.000	0.162	0.000	0 994	0 001	0 000	1 000	0.000

	13	14	15	16	17	18	19	20	21	22	23	24
13	1.000											
14	0.000	1.000										
15	0.022	0.860	1 000									
16	1 000	0 000	0.022	1.000								
17	0 000	0.826	0 010	0 000	1 000							
18	0 000	0 570	0 003	0 000	1.000	1.000						
19	1 000	0.000	0 022	1 000	0.000	0.000	1.000					
20	0 000	1.000	0 935	0 000	0.707	0.434	0 000	1 000				
21	0.015	0 914	1 000	0 015	0.015	0 005	0.015	0 966	1 000			
22	1 000	0.000	0.012	1 000	0 000	0.000	1 000	0 000	0.008	1.000		
23	0.000	1 000	0.707	0.000	0.935	0.750	0.000	1 000	0 790	0.000	1.000	
24	0 000	0.977	0 038	0.000	1 000	1 000	0 000	0.935	0.053	0.000	0 996	1.000

Appendix 3.13: Tukey's Post Hoc Test – Meads Creek RPD depth measure.

TIME - Tukey HSD Multiple Comparisons.

	0	2	4	6	9	11	13	15
0	1.000							
2	0.991	1.000						
4	0.869	0.394	1.000					
6	0.933	0.486	1.000	1.000				
9	0.486	0.110	0.999	0.991	1.000			
11	0.019	0.142	0.000	0.001	0.000	1.000		
13	0.999	1.000	0.537	0.640	0.181	0.084	1.000	
15	0.228	0.715	0.011	0.013	0.001	0.961	0.563	1.000

STATION - Tukey HSD Multiple Comparisons.

	Ref	Cage1	Cage2
Ref	1.000		
Cage1	0.000	1.000	
Cage2	0.000	0.000	1.000

Appendix 3.13 (Cont.):

COL/ROW – TIME/STATION - Tukey HSD Multiple Comparisons.

1	0-Ref	**9**	4-Cage2	**17**	11-Cage1
2	0-Cage1	**10**	6-Ref	**18**	11-Cage2
3	0-Cage2	**11**	6-Cage1	**19**	13-Ref
4	2-Ref	**12**	6-Cage2	**20**	13-Cage1
5	2-Cage1	**13**	9-Ref	**21**	13-Cage2
6	2-Cage2	**14**	9-Cage1	**22**	15-Ref
7	4-Ref	**15**	9-Cage2	**23**	15-Cage1
8	4-Cage1	**16**	11-Ref	**24**	15-Cage2

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000											
2	0.000	1.000										
3	1.000	0.000	1.000									
4	1 000	0.000	1.000	1.000								
5	0 000	1.000	0.000	0 000	1.000							
6	0 699	0.026	0.991	0 699	0.046	1.000						
7	1.000	0 000	1 000	1 000	0 000	0 699	1.000					
8	0 002	0.991	0 026	0.002	0.998	0.699	0 002	1 000				
9	0.000	0.000	1.000	1 000	0 000	0.851	1.000	0.011	1 000			
10	1 000	0 000	1.000	1.000	0.000	0.699	1 000	0 002	1.000	1.000		
11	0 001	1.000	0.008	0 001	1.000	0.417	0.001	1.000	0 004	0 001	1.000	
12	1 000	0 000	1.000	1.000	0 000	0 699	1.000	0 002	1.000	1.000	0 001	1 000
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
13	1.000	0.000	1.000	1 000	1.000	0.699	0 001	0.002	1 000	1.000	0 001	1.000
14	0 197	0 197	0 699	0.197	0.197	1 000	0 914	0.991	0.197	0 197	0 914	0 197
15	1 000	0 000	1.000	1.000	1 000	0 968	0.004	0 015	1.000	1 000	0 004	1.000
16	1.000	0.000	1.000	1.000	1.000	0.699	0.001	0 002	1.000	1 000	0 001	1 000
17	0.000	1.000	0.000	0.000	0 000	0 015	0.998	0.968	0.000	0.000	0 998	0 000
18	0 000	1.000	0 000	0 000	0 000	0.015	0 998	0 968	0 000	0.000	0 998	0 000
19	1 000	0 000	1 000	1.000	1 000	0 699	0 001	0 002	1.000	1.000	0 001	1.000
20	0.046	0.557	0 294	0.046	0.046	0 998	0.998	1.000	0.046	0 046	0.998	0 046
21	0 008	0.914	0 077	0 008	0.008	0.914	1.000	1.000	0.008	0 008	1.000	0 008
22	1.000	0.000	1 000	1.000	1.000	0.699	0.001	0.002	1 000	1.000	0.001	1 000
23	0.002	0.991	0.026	0 002	0.002	0.699	1.000	1.000	0.002	0.002	1.000	0.002
24	0 000	1.000	0 000	0 000	0.000	0.015	0.998	0.968	0 000	0 002	0.998	0.000
	13	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
13	1 000											
14	0.197	1 000										
15	1.000	0 557	1.000									
16	1 000	0.197	1.000	1 000								
17	0 000	0.126	0 000	0.000	1.000							
18	0 000	0.126	0.000	0.000	1.000	1 000						
19	1.000	0.197	1.000	1 000	0.000	0 000	1 000					
20	0.046	1 000	0.197	0 046	0 417	0.417	0.046	1.000				
21	0 008	1.000	0.046	0 008	0.823	0 823	0 008	1.000	1 000			
22	1.000	0.197	1 000	1.000	0 000	0.000	1.000	0.046	0 008	1.000		
23	0.002	0.991	0 015	0 002	0.968	0 968	0 002	1.000	1.000	0.002	1.000	
24	0.000	0 126	0 000	0.000	1 000	1.000	0.000	0.417	0 823	0 000	0.968	1.000